HELSINKI SCHOOL OF ECONOMICS
Department of Accounting and Finance

Non-Firm Specific Structural Determinants of Corporate Credit Spreads – New Evidence from US Bond Markets

Finance
Master's Thesis
Aatu Väinölä
Spring 2008

Approved by the Council of the Department 13 / 5 2008 and awarded the grade excellent, 80p.
Tarkastajat:
KTT, Matti Suominen
KTT, Matti Kelomarju

Helsinki School of Economics
Master's Thesis
Aatu Väinölä

Abstract
April 30, 2008

Non-Firm Specific Structural Determinants of Corporate Credit Spreads – New Evidence from US Bond Markets

PURPOSE OF THE STUDY

The purpose of this thesis is to investigate the effect of non-firm specific structural determinants on corporate credit spreads. The aim is to study which factors affect the changes in corporate credit spreads. Another aim of this study is to investigate how the factors have changed with the prevailing credit crisis in the US credit markets. The factors used in this study are: implied volatility of S&P 500 index options, market spot rate, slope of the yield curve, mergers and acquisitions activity, S&P 500 stock index, consumer confidence index and the rate of unemployment. The reason for the use of consumer confidence index and the rate of unemployment is to discover whether they work as better proxies for general business climate than S&P 500 stock index. M&A activity is used in order to see whether it has the capability of working as a proxy for a possibility of jump in firm asset value. Additionally, the aim is to thoroughly explain the theory of pricing corporate liabilities and the underlying theories behind the credit spreads.

DATA

The data in this study is monthly bond specific data from bonds included in the Dow Jones Corporate Bond Index. The bonds included in the index are US investment grade bonds from large corporations operating in US. The time period of the study is 2003–2007. The bond data was collected from Ryan Labs Asset Management database. The other data used in this study such as the M&A activity and unemployment rates are collected either from SDC database, Thomson One Banker or US government official publications.

RESULTS

The findings of the study are threefold. First, we find that market volatility and spot rate have been the strongest explanatory factors on changes on corporate credit spreads. Second, we find that S&P 500 index has been a better proxy for general business climate than consumer confidence index or the rate of unemployment. Third, we find that M&A activity is a statistically significant explanatory variable behind changes in credit spreads. This implies that it has the ability to work as a proxy for the probability of jump in firm asset value.

KEYWORDS

Corporate credit spreads, corporate bonds, credit crisis

Helsingin kauppakorkeakoulu
Pro-gradu tutkielma
Aatu Väinölä

Tiivistelmä
30 huhtikuuta, 2008

Joukkovelkakirjalainojen tuottoerojen yrityksille yhteiset rakenteelliset tekijät – Uusia tuloksia Yhdysvaltojen joukkovelkakirjamarkkinoilta

TUTKIMUKSET TARKOITUS

Tämän pro-gradu tutkielman tarkoituksena on selvittää yrityksille yhteisten rakenteellisten tekijöiden vaikutusta yritysten joukkovelkakirjalainojen tuottoerojen muutoksiin. Tutkimuksen tehtävänä on selvittää mitkä muuttujat aiheuttavat muutoksia joukkovelkakirjalainojen tuottoeroihin. Tutkimuksen toinen tarkoitus on tutkia miten selittävät muuttujat ovat käyttäytyneet Yhdysvalloissa vallitsevan luottokriisin aikana. Tässä tutkimuksessa käytettävät muuttujat ovat: S&P 500 indeksioptioiden implisiittinen volatiliteetti, markkinakorko, korkokäyrän muoto, yrityskauppa-aktiviteetti, S&P 500 osakeindeksi, kuluttajaluottamusindeksi sekä työttömyysaste. Kuluttajaluottamusindeksin ja työttömyysasteen käytön syynä on selvittää onko niillä parempi kyky selittää talouden yleistä tilaa kun S&P 500 osakeindeksillä. Yrityskauppa-aktiviteettia käytetään, jotta voidaan selvittää pystyykö se kuvaamaan yrityksen arvon äkillisen muutoksen todennäköisyyttä. Edellä mainittujen lisäksi, tutkimuksen tavoitteena on perehtyä perusteellisesti yrityslainojen hinnoitteluteorioihin sekä joukkovelkakirjalainojen tuottoeroihin keskittyvään teoriaan.

DATA

Tutkimuksen datana käytetään kuukausittaista dataa joukkovelkakirjalainoista jotka kuuluvat Dow Jones Corporate Bond indeksiin. Indeksiin kuuluvat joukkovelkakirjat ovat hyvän luottoluokituksen omaavien Yhdysvalloissa toimivien suurten yritysten liikkeelle laskemia. Tutkimuksen aikajakso on 2003–2007. Joukkovelkakirjadata on kerätty Ryan Labs Asset Managementin tietokannasta. Muu tässä tutkimuksessa käytetty data, kuten yrityskauppa-aktiviteetti ja työttömyysaste on kerätty joko SDC tietokannasta, Thomson One Banker tietokannasta tai Yhdysvaltojen valtion virallisista julkaisuista.

TULOKSET

Tutkimuksen tulokset ovat kolmijakoiset. Ensiksi havaitsemme, että markkinoiden volatiliteetti ja korkotasot ovat olleet vahvimmat joukkovelkakirjalainojen tuottoerojen muutoksia selittävät tekijät. Toiseksi havaitsemme, että S&P 500 osakeindeksi on parempi kuvaaja talouden yleiselle tilalle kuin kuluttajaluottamusindeksi tai työttömyysaste. Kolmanneksi havaitsemme, että yrityskauppa aktiviteetti on tilastollisesti merkitsevä selittävä tekijä joukkovelkakirjalainojen tuottoerojen muutoksissa. Tämä merkitsee, että se on toimiva muuttuja kuvaamaan yrityksen arvon äkillisen muutoksen todennäköisyyttä.

AVAINSANAT

Joukkovelkakirjalainojen tuottoerot, yritys joukkovelkakirjalainat, luottokriisi

Table of Contents

List of Tables:

List of Figures:

1. Introduction

The assessment of risk related to investing in financial securities can be considered as one of the most essential aspects of studies in economics and finance. This paper is going to focus on the risk factors of corporate debt. We are going to study the effect of non-firm specific structural determinants on corporate credit spreads changes. The variables used are based on the contingent-claims model initially created by Black and Scholes (1973) and Merton (1974), and they can all be considered to be related to firm default risk. This topic is relevant since the factors behind credit spread changes are still partly unclear. In addition the prevailing market situation makes the study on corporate credit spreads extremely current.

1.1 Academic and Practical Motivation

Motivation for this study is two folded. First there is the academic literature that has tried to specify the risks of corporate bonds for decades. Second, there is the practical motivation related to the prevailing credit market situation in US that has once again made the study on the risk factors of corporate credit spreads current.

The structural determinants pricing method created by Black and Scholes (1973) and Merton (1974) and later evolved by e.g. Black and Cox (1976) and Longstaff and Schwartz (1995) show that variables related to firm's default risk are essential for valuing risky debt. Collin-Dufresne et al. showed that firm leverage ratio, market volatility and spot rate are all able to explain changes in credit spreads with statistical significance. This study aims to elaborate on the study of Collin-Dufresne et al. (2001) by using new data and new macroeconomic variables in order to explain changes in corporate credit spreads. We find that in addition to volatility and interest rate level, the corporate restructuring activity plays an important role in explaining the changes in corporate credit spreads.

The practical motivation for this study mostly stems from the prevailing credit market situation in the US markets and from the author's personal demand for more thorough knowledge on fixed income instruments. The idea of a fixed income Master's Thesis became a necessity when the sub-prime crisis broke out at summer 2007 and when the author found himself signing a job from fixed income desk. Thus it can be said that the purpose of this thesis is to provide new information about corporate credit spreads and simultaneously educate the author about the topic.

1.2 Research Problem and Purpose

The research problem of this study is as follows: What is the effect of macroeconomic variables on corporate credit spreads and what are their implications. The research problem can be further divided into three sub-problems. First, what is the effect of structural determinants of credit spreads, which are related to the default risk of a firm? Second, what is the effect of non-default related variables such as consumer confidence index and unemployment rate to credit spreads? And third, how has the macroeconomic variables changed during the prevailing credit crisis in the US financial markets? In addition to these research problems, one of our goals in this study is to give the reader an extensive look into the theory and literature of pricing corporate liabilities and credit spreads.

1.3 Contribution of the Study

This study contributes to existing literature in at least two different ways. First, it tests the changes in credit spreads with fresh from the oven dataset from 2003 to 2007. This dataset enables us to see whether the results of previous studies have still been applicable in the past five years. The dataset also enables us to take an in depth look at credit crisis of 2007. We can study whether the variables act differently at times of severe financial distress and whether the prevailing credit crisis would have been in any way predictable from the variables that we are using in our study. The second way that this study contributes to existing study is that it

provides three new variables to explain the change in the systematic part of the credit spread. These variables are the change in mergers and acquisitions activity, change in consumer confidence index and unemployment rate. We find that these three variables actually have as expected signs, but only the effect of mergers and acquisitions activity is able to explain credit spreads at statistically significant level.

1.4 Limitations of the Study

The limitations of this study are strongly correlated with our dataset. Unfortunately the bond market data is much more difficult to collect than data from e.g. equity markets. The problem that arose in this study is that the observation time of each bond is relatively short and thus it is not possible to reliably measure the company specific factors affecting credit spreads. Due to this frailty in our dataset we must focus our study to macroeconomic variables only. This, however, is not considered very critical since multiple studies have already studied the effect of company specific factors such as firm leverage ratio to credit spreads. In this study we are also going to look at the effect of leverage ratio on credit spreads, but only by categorizing the bonds by issuers leverage ratio.

Another limitation of this study relates to the prevailing credit crisis on US financial markets. Our dataset extends to December 2007, which makes the sample size on the credit crisis quite small. As we have seen year 2008 has so far been a year of extreme market turbulence and uncertainty. Thus it would have been optimal to have a dataset reaching to at least summer 2008. This kind of arrangement, however, was impossible to arrange due to the schedule of author's graduation.

1.5 Structure of the Study

The structure of this study is as follows. In chapter 2 we are going to give a quick briefing to basic information about corporate liabilities and their pricing methods. In chapter 3 we are going to present the theoretical background of the study by first looking at the factors that have been found to have an effect on the changes of corporate credit spreads and second, by looking more specifically about the factors that have been used in explaining the changes on credit spreads. In chapter 4 we are going to present the main hypotheses of this research. Chapter 5 introduces the data and methodology used in this study. In chapter 6 we are going to present the empirical results found. And finally, in chapter 7 we are going to conclude the study by briefly looking at the implications of the findings and by making some propositions for further studies.

2. Fixed Income Securities

We will start this section by looking at the most basic characteristics of fixed income securities. We are first going to give a picture of what are fixed income securities, their most common characteristics and what are the risks involved in investing in them. After that we are going to look in what type of market fixed income securities and especially corporate bonds trade. Finally in this part we are showing you the most established ways to price corporate liabilities.

2.1 Introduction to Fixed Income Instruments

Fixed income securities, often referred to bonds are securities where the issuer promises to make a fixed payment at a future point in time. For example: Firm A borrows $90 from Investor B against a promise that it will repay Investor B $100 dollars in two years of time. If the agreement is made, Investor B possesses an instrument with fixed income. This means Investor B knows the amount of money that he or she will receive, assuming that Firm A does not default on its promise to repay the loan. The instrument described in the example is a zer-coupon corporate bond, the simplest fixed-income security, where the borrower does not pay any interest to the principal, but rather sells the bond with a discount to its buyer. In real world there are countless different types of fixed income securities that differ in terms of issuer, maturity (time of repayment), coupon (interest paid to debt) and several other bond specific terms.

There are at least three extremely important descriptive characteristics in bonds that describe their nature: issuer, maturity and coupon. We are first going to look at the role of the issuer. According to Fabozzi (2005) the three largest issuers of debt in US are corporations, municipal governments and the federal government. The nature of a bonds issuer has a large impact on the nature of the bond in terms of e.g. risk, taxation and secondary market trading. Another important feature in a bond that we mentioned is maturity. Maturity refers to the number of years during which the issuer has promised to meet the conditions of the debt.

Maturity is crucially important since it is closely related to almost all risks involved in investing in fixed income securities. As one might reason with common sense, the longer the time an investor has to wait until he receives his payment the larger is the possibility that something bad happens. Maturity is such an important feature of a bond that the maturity date (date at which the issuer has to meet the claims) is mentioned in the name of every bond. The third crucially important feature of a bond is its coupon, which is a periodic interest payment made by the issuer to the holder of the debt security. The coupon is normally cited as the coupon rate which is the percentage proportion of the coupon's size in comparison to the face value (value received at maturity) of the bond. Bond's coupon is also cited in the name of the bond. Thus for example a name of a bond can be quoted as 'WALT DISNEY 2002 6 3/8% 01/03/12', which means that the bond was issued in 2002 by Walt Disney corp. and it has a coupon rate of 6 3/8% and it matures at January 3rd, 2012.

2.1.1 Differences Between Corporate and Government Bonds

The broadest way to categorize bonds by issuer is to divide the world of bonds into government bonds and corporate bonds. Even though theoretically there is not much difference between these two categories, in real world corporate bonds have some distinctive differences compared to government bonds. First, corporate bonds carry a risk of default also known as credit risk, which is an essential concept related to this study. Credit risk means that if a firm that has issued bonds phases an event of bankruptcy, the issuer may be unable to fully repay the debt, which causes the investors to lose at least part of the funds they have invested. However, bondholders have a prior legal claim over common and preferred shareholders to company's assets and income. A default of government bonds on the other hand, is practically impossible, since a government can always print its own money.[1] This additional risk compared to government bonds with many other risks that are later discussed in this study lead to existence of corporate credit spread, which is the difference between a

[1] Many European countries do not enjoy this possibility anymore due to the collective EURO currency used in EMU countries. It is also possible for a country to default on its liabilities on foreign currencies, since a country cannot print foreign money.

corporate bond's yield and the yield on a benchmark government security with comparable maturity.

Corporate bonds are also often more complex instruments than government bonds. Where government bonds are often straight bonds with constant coupon payments, corporate bonds may have several innovative features built in them. The corporate bonds are often found to be callable, putable, subordinated, inflation-linked etc. Embedded options that are built into some corporate bonds make the pricing of corporate bonds often quite complex.

2.1.2 Risks of Debt Instruments

There are several risks related to debt securities. In general, the most obvious risk is the credit risk that is related to corporate debt (and actually to all other debt securities where the issuer may default on its obligation). In this section we are quickly going to present some of the most acknowledged risks that are related to debt instruments. We are going to start with credit risk, which is a specific risk related to issuers that can default on their debt obligations.

Credit risk. As mentioned earlier, one of the most defining characteristic of corporate liabilities is the possibility of default. If a firm phases bankruptcy, it is most likely unable fully to repay all its outstanding debt. Thus the credit risk of a bond is present in practically all bonds where the issuer of the bond may default on its debt obligation. The credit risk is binary: first, there is the risk that the company defaults on its promise and second, there is the possibility that due an increased risk of default, the investors will demand a higher yield, which results into a situation where the price of the bond depreciates in comparison to similar bonds. Thus credit risk is relevant for all investors investing in corporate debt in despite of their investment horizons.

Interest rate risk. This risk is present because interest rates and the price of a typical fixed income security are closely related. As interest rates increase the price of a fixed income

security decreases and vice versa. If an investor is holding his asset to maturity this risk is not so important, because one knows what he is going to receive at maturity. If, however, an investor may sell the bond before maturity this risk plays and important part. For example, if an investor holds a bond while interest rates increase the investor may face capital loss if he wants to liquidate his position.

Reinvestment risk. This risk is also closely related to interest rates. When calculating returns for investments it is often assumed that cash flows received from an investment are reinvested. The reinvestment risk therefore relates to the risk of getting interest on interest i.e. interest to the coupon payments made by the issuer. If for example interest rates have declined the investor may not be able to reinvest the received cash flows with as high yield as he has made the initial investment at. This risk is greater for longer holding periods since the effect of interest on interest increases exponentially over time.

Call risk. In some cases a bond may contain a provision to allow the issuer to 'call' the bond before its maturity. This means that if interest rates decline enough the issuer may want to call the bond and refinance its need with a lower interest rate. This proposes a risk because it creates uncertainty to the bond holder in terms of uncertain future cash flows. Call risk also creates reinvestment risk because callable bonds are only called when interest rates have declined to low levels.

Yield curve risk. Fabozzi (2005) defines yield curve as the "graphic depiction of the relationship between the yield on bonds of the same credit quality but different maturities". The yield curve most often discussed in public is the 'treasury yield curve'. Yield-curve risk is related to the way how bond yields react to changes in yield curve structure. For example bonds with differing maturities may react differently to changes in yield curve. This risk is important especially in hedging situations where a trader hedges his position with a bond that has a different maturity than the one that creates the position in the first place.

Inflation risk. Inflation risk is almost always present with fixed income investments, because even though the payment at maturity is fixed inflation can change during the holding period and therefore reduce the real value of the investment. Today there are inflation-adjusted securities that promise a fixed real return for an investor. Besides these instruments, every fixed income security carries inflation risk.

Liquidity risk. Liquidity risk only considers investors who are not planning to hold the security until maturity. Liquidity risk arises when an investor wants to sell his security before maturity and there is no liquid secondary market for the security. For example let's assume that an investor wants to sell his bond at the secondary market. The last trade made with the bond was at $97.625 (expected here as the true value of the bond) but currently the best bid at the market place is $97.125. This means that if the investor wants to sell his security now he will lose $0.50 due to the poor liquidity at the market. Marketplace liquidity is often measured with the market bid-ask spread which is the difference between the lowest offer quote and the highest bid quote.

Event risk and political risk. Occasionally there might be some fundamental changes in the issuing company due to for example corporate restructurings, industrial accidents, natural catastrophes etc. These kinds of risks are commonly classified as event risk. Event risks are tricky because they are very difficult to predict and their consequences may be remarkable. Political risks are similar to event risks in a way that they are often unexpected. Political risk occurs when for example a government changes its taxation policy or presents new laws that have an influence on the debt holder's status or position.

Foreign exchange risk. This risk is present when a bond is denominated in a different currency than is the investors 'home currency'. For example if a Finnish investor who is measuring his investment returns in Euros invests to a bond that is denominated in US dollars. If the US dollar depreciates in comparison to Euro during the investment period the investor is receiving fewer Euros per dollar than he would have if the exchange rate would have been fixed. The currency rates can of course work the other way around if the non-Euro denominated currency appreciates during the investment period.

2.2 Secondary Bond Markets

In this part of the chapter we are briefly going to introduce the reader to secondary bond markets in order to give the reader a better understanding to the topic of study.

2.2.1 Basics of Secondary Bond Markets

Secondary bond market is the place where bonds that have been issued previously are traded. The secondary bond market has two important roles. First, it gives the original buyer of a bond an opportunity to sell the bond before maturity and thus reallocate her funds as she pleases. This means that not only does the market offer a possibility to sell a bond before maturity by creating liquidity; it also gives the investor the possibility to get information about the fair consensus value of a bond. The information about bond's pricing is also available for potential investors, which means that the secondary market keeps the costs of transactions low by keeping the costs of both searching and transacting at low levels. Second, it allows the issuer of the bond to obtain information about the values of the bonds it has issued. This is beneficial for at least two reasons. First, the company can see how the market is pricing the risk of the company's credit. Second, the company can make estimations about how receptive investors would be to new offerings and at what prices.

Even though the secondary bond market works as a source of information in a similar way to the equity market, they have some distinctive differences. The equity market is generally viewed as a rather liquid market place where the trades are executed automatically through computerized systems. In this kind of market the traders and investors place buy and sell orders of their desired size and price and the trades are automatically matched in compliance with the rules of the stock exchange. In a secondary bond market, however, the market is often much thinner, which means that the market itself is quite illiquid. Because the liquidity of a bond market is often much weaker than in an equity market, majority of the trades in bond markets are executed at so called OTC (Over-The-Counter) market through brokers. In contrast to automated markets, OTC market is not a centralized market and works more as a

network of dealers which provide bid and offers for bonds that they are interested at. Due to the use of OTC trades in the bond markets the public cannot observe the intraday bond prices in a way that they are able to observe the equity prices from e.g. television or internet. This means that in a bond market a big brokerage house has a significant information advantage compared to public.

In addition to liquidity the bond market differs from equity market also in a form of transaction costs. Edwards et al. (2005) stated that the poor transparency of bond markets relative to equity markets may be the driver for higher transaction costs in the bond markets. The transaction cost differences between equity markets and bond markets are at largest for retail investors. The authors state that where the average spread in equity markets for retail trades is less than 40 basis points, the estimated cost for a bond transaction with value of $20,000 is as much as 138 basis points. However, unlike in the equity markets, bond transaction costs are much lower for institutional size transactions.

In contrast to liquidity and transparency, volatility on the other hand, is similarly present both in the bond markets and in the equity markets. As we have seen many times in the history (one late example could be for example the Bear and Stearns crisis), both the equity market and the bond market can be incredibly volatile in times of financial distress. In extreme situations a flight to quality often occurs, which means that investors are only investing in the high quality instruments and are cleaning their portfolios from the risky securities. This is also true at the bond markets. In equity markets the flight to quality is often towards investment grade companies with large market capitalizations and stable cash flows over business cycles. In bond markets however, the flight to quality is often towards the Treasury bonds. If one is willing to take the interest rate risk, the safest instrument to be investing is a US government Treasury bond. In times of financial distress investors are selling more risky bonds and buying the less risky ones. This phenomena result into an increase in the corporate credit spreads and into increasing illiquidity in the corporate bond market. The bond market can also be volatile in more stable times of the economy. This is because changes in bond prices are inversely related to changes in interest rates. Thus as mentioned earlier, if interest rates rise, bond prices fall and vice versa.

2.2.2 Differences Between Corporate and Government Bond Markets

Within the bond market there are some differences in how securities are traded. Even though technically trading government and corporate bonds is very similar, there are distinctive differences in trading corporate bonds rather than government bonds. The government bond market is often found to be a much more liquid market place than the corporate bond market. The US Treasury market is actually one of the most active and most liquid markets in the world. Contradictory, this is definitely not the case with the corporate bond market. The average daily trading volume of US Treasury securities in Q4 2006 was approximately $500 billion; whereas the equivalent trading volume for all corporate bonds traded in US was only approximately $12 billion.[2] Thus it can be stated that the liquidity risk is clearly worth taking into consideration when investing in corporate bonds. One explanation for the poor liquidity in the corporate bond markets can be its transparency, which has not been at the level that investors have hoped it to be. In 1998, Arthur Levitt, the former chairman of the Securities and Exchange Commission noted that "the sad truth is that investors in the corporate bond market do not enjoy the same access to information as a car buyer or a home buyer or, I dare say, a fruit buyer".[3] A more recent comment about the transparency of the corporate bond market came from Duncan Niederauer, chief executive of NYSE Euronext, in February 2008, stated in a interview related to bond markets that "there clearly seems to be a lack of transparency around a specific part of the market".[4] However, the problem with the market transparency has been grasped by US regulators as they have approached NYSE Euronext in order to use their bond-trading platform to boost the transparency in fixed income markets.[5]

The low liquidity of some corporate bonds has forced the financial institutions to be creative in pricing these instruments. As a result 'matrix pricing' systems have been created where dealers artificially quote a price for a bond with certain characteristics to best view the true value of the bond. Even though these prices are quoted they are not actual market prices of

---

[2] Source: SIFMA: Securities Industry and Financial Markets Association, Economic Outlook June 26, 2007.
[3] Wall Street Journal, September 10 1998.
[4] Financial Times, February 8 2008, By Anuj Gangahar, New York
[5] Financial Times, February 8 2008, By Anuj Gangahar, New York

trades that have been executed at the market but just estimations about where the price could be if the bond would trade.[6]

2.3 Pricing of Corporate Liabilities

In order to understand the changes occurring in corporate credit spreads we must first look at the basics of pricing corporate liabilities. In this section of the chapter we are briefly going to go through the most recognized models for pricing of corporate liabilities. We are going to look at the pricing models in a chronological order starting from the discounted cash flow method, the roots of which are not clear in history. After the discounted cash flow method we will look at the seminal option pricing model of Black, Scholes and Merton, which started a totally new phase in the science of pricing options and corporate liabilities. We will also go through the Black and Cox (1976) model, the binominal tree model and some multifactor models that have been created.

2.3.1 Discounted Cash Flow Method

The most common way to price bonds and still the back pillar for the pricing of almost all financial securities is the discounted cash flow method. Using the method of discounting the future cash flows with the expected rate of return is a basic concept of economic literature that is probably taught in every business school in the world. In his book *The Theory of Interest* Fisher (1930) noted that "The price of a bond is calculated from two items, the rate of interest to be realized and the series of sums or other benefits which the bond is going to return to the investor. Aside from risk, there can never be any other factors in the calculation except these two". Thus it has been acknowledged for a long time that by discounting the future coupon payments and the returned capital, one can simply determine the value of corporate liability quite accurately. Much before the sophisticated models of the modern era researchers, have

---

[6] More about matrix pricing see e.g. Kagraoka 2004.

people known that the best way to value payments made in the future is by discounting them with appropriate expected return.

The idea of discounted cash flows is still present in practically every established pricing model of modern finance. It is the cornerstone of modern finance in multiple ways. The more complex mathematical pricing formulas of today are just trying to determine the risk factor that Fisher (1930) mentioned.

2.3.2 Black-Scholes-Merton Model

One of the major drawbacks of the classical discounted cash flow model is that it is practically impossible to determine the expected return on a bond by just sheer approximation. This deficiency encouraged researchers to find more sophisticated pricing models for corporate liabilities, because even though the simple discounted cash flow method is excellent for making fast back of the envelope calculations on the value of a firm's debt, it is insufficient to be used in more complex pricing circumstances.

In 1973 Black and Scholes and Merton independently created an option pricing model that could also be used in pricing corporate liabilities. The researchers showed that with certain limits the value of a bond is a function of the value of a firm's assets. Black, Scholes (1973) and Merton (1973) showed that their option pricing model can be used as a tool for valuing bonds since owning a bond results in a same position as having a short position on a put option on the company's assets. To focus on this Merton (1974) stated that the inputs for determining the price of a bond are the following: the required rate of return on riskless debt, the bond specific terms (e.g. maturity date, coupon, callability, seniority etc.) and the probability of default. However, in order to be able to price the liabilities and to use the option pricing formula some quite rigorous assumptions had to be made. In order for the Black-Scholes-Merton pricing model to work the market must be perfect. In addition, the model has two other important assumptions that are at least as important to the model as the assumption of perfect markets. The first one is that trading in assets takes place continuously in time.

Basically this means that the market for trading of these securities would be open 24 hours a day 7 days a week. Thanks to different time zones, this might be true for some financial instruments, but for corporate bonds this is most definitely not the case. The second critical assumption of the model is that the value of the firm through time is a diffusion type stochastic process. The stochastic differential process of the firm value *(V)* is

$$dV = (\alpha V - C)\, dt + \sigma V dz \qquad (1)$$

where α is expected rate of return on the firm, C is the total dollar payouts of the firm σ^2 is the variance of the return of the firm; *dt* is the drift term and *dz* is a standard Wiener process.

By using the stochastic process to value the firm the model assumes that the firm defaults its debt at time when it exhausts its assets. This is generally considered to be one of the drawbacks of the model since firms may well default much earlier than all its assets are exhausted. This assumption cause the model to give too low probabilities of default since the threshold of default is so high. In addition to this there are some other generally acknowledged pitfalls in the Black-Scholes-Merton corporate liability pricing model that need to be addressed. First, is that the underlying security in the model, which in this case is the value of the firm is not directly tradeable. This makes it difficult to observe the value of the firm. Second, if the model is used to pricing bonds of a firm which has many liabilities, the computation is going to be difficult. Third, the underlying assumption of the model is that it assumes constant interest rates. It seems difficult to justify the assumption in a valuation model for risky fixed-income securities. Especially in times like these with heavy turbulence on the interest rate markets. As a result the Black-Scholes-Merton approach has not proven very effective in practice for pricing corporate liabilities[7]. To conclude Jones et al. (1984) stated that the three crucial assumptions in the Black-Scholes-Merton model that reduce the practicality of the model are perfect liquidity, irrelevance of taxes and non-stochastic interest rates. Thus, even though being pioneering and worth a Nobel-Prize the model has its

[7] See: Jones Mason Rosenfeld (1984).

deficiencies related to its use in practice. These deficiencies have inspired academics to develop the model into direction where it would be more usable used in real life. This trend has led to new pricing methods that have tried to ease the strictest assumptions of the original model.

2.3.3 Black-Cox Model

After the Black-Scholes-Merton model had gained its reputation in the world of corporate finance, researchers started concentrating on improving the model and trying to ease the somewhat rigorous assumptions of the model. One significant step forward on the pricing theory was created by Black and Cox (1976) who were successfully able to show that the value of the firm and the probability of default can be made more realistic by adding some boundary conditions to the model. Black and Cox (1976) state that one of the pitfalls of the Black-Scholes-Merton model is that it assumes that the fortunes of the firm may cause its value to rise to an arbitrarily high level or diminish to practically zero without any reorganization occurring in the firm's financial arrangements. What Black and Cox (1976) were able to do was to insert boundary conditions to the value of the firm so that it would become more realistic. This way the model is consistent with either net-worth or cash-flow-based insolvency and making the default conditions more realistic. By doing these changes the Black-Cox model is able to give more consistent spreads with those observed in the corporate bond market.

However, despite the significant improvements of the Black-Cox model compared to the Black-Scholes-Merton model, the other pitfalls such as the non-stochastic interest rates of the Black-Scholes-Merton model were still present in the Black-Cox Model.

2.3.4 Binomial Tree Model

In 1979 Cox et al. introduced a simplified approach to valuing options and corporate liabilities. This model today is known by the name binomial tree model and is a very common tool used in pricing options and corporate liabilities. In contrast to the continuous-time model of Black, Scholes and Merton the binomial tree model is a discrete-time model having the same mathematical limit value as the Black-Scholes-Merton model. The greatness of the binomial tree model was that it made it possible for investors to value options by using just basic elementary mathematics. With the use of the binomial tree model it was also relatively easy to value more complex financial instruments such as callable or convertible bonds. Even though this model did not carry the theoretical framework of pricing options any further, it provided a simple and accurate way to price options and corporate liabilities and is thus still taught and used in many business schools and financial services companies all over the world.

2.3.5 Towards Multifactor Models, Longstaff-Schwartz Model

After the Black-Scholes-Merton and Black-Cox pricing models, the academic research focused on loosening the assumption on constant interest rates. In 1995 when Longstaff and Schwartz (1995) introduced their extended version of the Black-Cox pricing model with stochastic interest rates, they were not the first researchers that had introduced a model that allow risk for both default risk and interest-rate risk.[8] However, according to Longstaff and Schwartz (1995) were the first ones to provide closed-form valuation expressions for risky coupon bonds as well as floating-rate debt. The authors also state that it is the first model that jointly allows: (a) default before the firm exhausts all its assets, (b) complex capital structures including multiple issues of debt, (c) deviations from strict absolute priority and (d) empirical evidence supporting the implications of the model. The authors stress that the importance of their model lies in the fact that it can be applied directly to value risky debt when there are many coupon payment dates or when the capital structure of a firm is very complex.

---

[8] Other models include e.g. Ramaswamy Sundaresan (1986), Hull White (1995), Jarrow Turnbull (1995)

2.3.6 Other Multifactor Models

Especially after the pricing model of Longstaff and Schwartz (1995) the development of new multifactor pricing models has been an active area of research. It is now widely accepted that the original work of Black, Scholes and Merton is an excellent pillar to build more complex model on, but as a standalone model is insufficient to explain the credit spreads.

Jarrow and Turnbull (1995) introduced a model where the price of a corporate liability is explained by a function of term structure of risky debt (introduced by Merton (1974)) and a stochastic process for the evolution of the default-free term structure of interest rates by using a martingale measure technology. Madan and Unal (1999) also introduced a two factor model where the risk factors were the value of cash assets and the level of stochastic default free interest rates. However, what made the study of Madam and Unal (1999) very different from the model of Jarrow and Turnbull (1995) was that Madam and Unal (1999) added an exogenously specified hazard rate model to the likelihood of a firm's default. This means that a single highly unexpected event is capable of making the value of equity zero or even below. A major advantage of this approach is that first, it is more realistic than a fully stochastic process and second they create realistic short maturity credit spreads. Recent examples about the acceptability of this kind of model are the bankruptcy of Enron in 2001 and the financial crisis of Bear Stearns in 2008. For example in Enron the accounting fraud was done so thoroughly that the investors could not possibly have expected such a severe hazard. The financial crisis of Bear Stearns Companies Inc. was also something that was totally unexpected to the financial world. On Friday March 14, 2008, Bear Stearns announced that it has significant liquidity problems, which resulted into an intervention by Federal Reserve and JP Morgan and into a stock price decline of 40 percent. On Sunday March 16, 2008, JP Morgan announced the purchase of Bear Stearns at $2.00 a share. This heavily discounted price lead to a price decline of Bear Stearns stock by 84 percent. In light of these examples it can definitely be argued that a corporate liability pricing model is not fully complete without a hazard rate model.

Mueller (2000) also created a multi-factor framework for pricing of corporate bonds. In their model, in addition to leverage ratio of the firm and the risk free rate of interest, the bond price is also a set of economic factors that can be estimated. The model of Mueller (2000) was able to generate reasonable credit spreads for all maturities. The researchers stated that: "Through the dependence of credit spreads on multiple factors, the multi-factor corporate bond-pricing model is able to generate a greater and more realistic time-series variability of credit spreads". Mueller (2000) tested their own model to bonds of a single firm and found that the model has the potential to improve the fit of the structural credit risk model.

Currently the academic research around the multifactor models is quite active and researchers are trying to find more economic factors that would scientifically explain the risks related in corporate bonds. Some investment banks have evidently used models where the price of a bond is a function of over six variables. However, the scientific bases of these models are yet to be discovered.

3. Theoretical Background and Previous Research on Credit Spreads

Now that we have shown the basic instruments for valuing corporate liabilities it is time to go more specifically to the puzzle of corporate credit spreads. This is chapter has an essential role on the study because it justifies the variables we are going to use in explaining changes in credit spreads. We are going to start by first presenting the basic information about credit spreads and also about their development in US. After that we are going to go through some of the most important theories and studies that are explaining the structure and changes of credit spreads.

3.1 Introduction to Credit Spreads

3.1.1 A Simple definition of Credit Spread

Investors demand a return premium for additional risk that they take; this is called the risk premium. Risk premium is the difference between the yields of otherwise identical Treasury and non-Treasury security. Fabozzi (2005) defines US Treasury securities as obligations of the US government issued by the Department of the Treasury. He states that they trade in a highly liquid secondary market and are used by market participants for example as a risk-free benchmark. Onwards in this study the risk premium is known as *credit spread.* By using the credit spread the interest rate of a non-Treasury bond can be described as:

$$Interest\ Rate = Base\ Interest\ Rate + Credit\ Spread$$

There are multiple underlying factors that affect the size of the spread e.g. type of issuer (e.g. state, municipality, corporation etc.), credit worthiness of the issuer, maturity of the issue, taxability of the issue (US government bonds and US corporate bonds are taxed differently), liquidity of the issue etc. The underlying factors that affect the size of the credit spread have

been an active topic with the researchers during the past decade and are also the focus of the empirical part of this study.

The credit spread can generally be divided into three parts. First part of the spread is the *default spread* which relates to the fact that corporate bonds have default risk. Thus part of the credit spread must exist due to this risk. The second part of the credit spread is the *Tax Spread* which exists due to the different tax treatments between corporate bonds and government bonds in US. Because of the favoring tax treatment of Treasury bonds, they must be trading at higher prices (i.e. lower yields). According to Elton et al. (2001) the last and the most controversial part of the spread is the *Risk Premium*. This relates to the fact that there exist additional factors besides default risk and tax treatment that explain the credit spread.

$$Credit\ Spread = Default\ Spread + Tax\ Spread + Risk\ Premium$$

Later in this study we are going to go through the most important studies done on the structure of the credit spread.

3.1.2 Term Structure of Credit Spreads

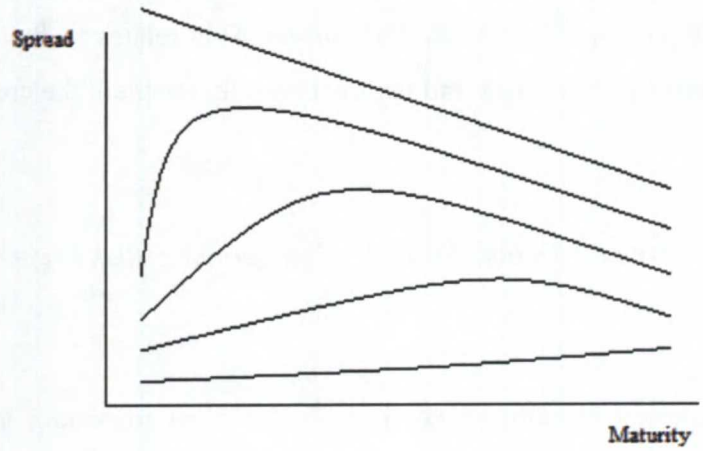
Term structure of credit spreads is the term that explains the behavior of credit spreads in terms of bond maturity (Fons 1994). At first one might think that credit spreads always increase with maturity, this however, is not the case. Merton (1974) stated that contrary to what many may believe the relative riskiness of debt can decline as the time until maturity increases. Thus depending on the bond, credit spreads can either increase or decrease with maturity.

Leland and Toft (1996) state that the term structure of credit spreads is increasing function with maturity with low leveraged firms. When leverage increases the terms structure reaches a

humped shape in which the spread first increases with maturity but then starts to decrease as maturity gets longer. He et al. (2000) go further and create five bond credit spread categories in terms of quality of the credit. Figure 1 shows the classification made by He et al. (2000) the undermost line being the highest credit grade and the uppermost line representing the lowest credit grade.

Figure 1: Theoretical Term Structure of Credit Spreads

This figure represents the term structure of credit spreads for bonds of different credit grades. In the figure the uppermost line is the lowest grade debt whereas the undermost line represents the highest credit grade. Source: He et al. (2000).



Despite the findings of the authors mentioned above, the shapes of term structure of credit spreads have not been unambiguously stated to be as they are. However, there seems to be some kind of consensus that the term structure is increasing for best credit quality bonds and humped shaped for bonds of lower credit quality. Longstaff and Schwartz (1995) showed that depending on the default-risk variable and on the percentage write-down on a security in case of reorganization, the term structure can take either an increasing or humped shape.

3.1.3 Categorizing the Default Risk – Credit ratings

Fabozzi (2005) determines credit rating as the "formal opinion given by a specialized company of the default risk faced by investing in a particular issue of debt securities". The

credit ratings are provided by rating agencies of which the two largest and most internationally recognized are Moody's Investors Service and Standard & Poor's Corporation. The process of defining a credit rating for debt securities is complex, and is not covered in this paper. However, we can say that the underlying factors influencing the credit ratings are e.g. industry risk, economic cyclicality, leverage ratio, research and development expenses, degree of regulation, competition, management etc[9].

The credit rating agencies use simple alphabetic systems to summarize the creditworthiness of a firm. Bonds that are rated between AAA – BBB- on Standard and Poor's or Aaa – Baa3 on Moody's are regarded as 'investment grade bonds'. Bonds that are rated BB+ or below on Standard Poor's or Ba1 on Moody's are generally known 'speculative grade bonds' or 'junk bonds'. The rating scales of Moody's and Standard & Poor's are similar to each other and are illustrated on Table 1.

[9] Source: Corporate Ratings Criteria (2006), Standard & Poor's

Table 1: Credit Rating Categories

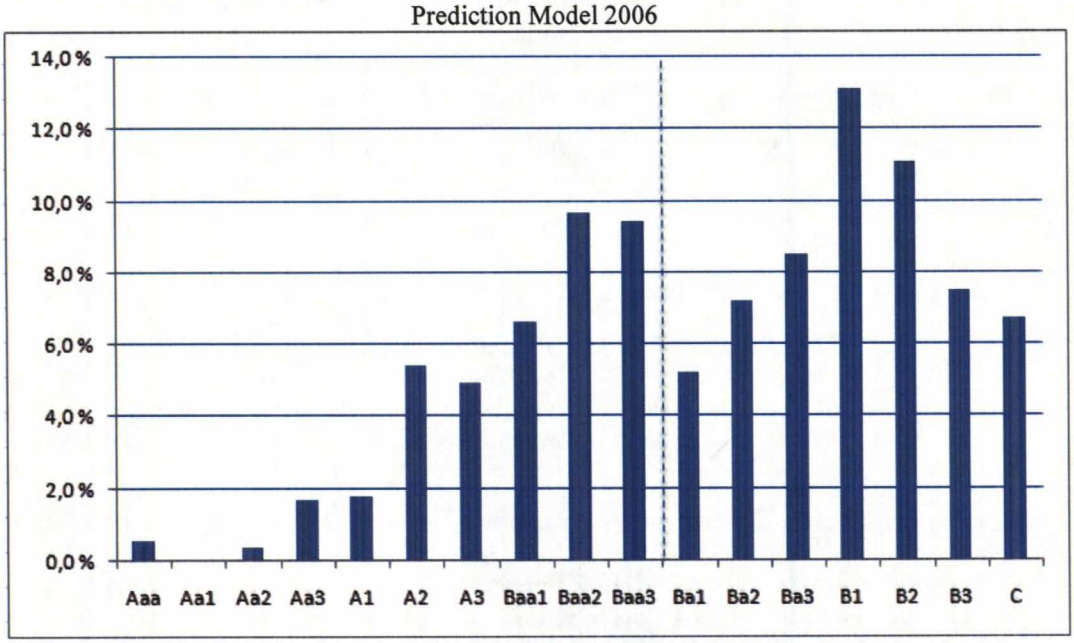
This table illustrates the credit ratings of two most internationally recognized credit rating agencies, Moody's Investors Service and Standard & Poor's Corporation. As can be seen from the table, the rating symbols are quite easily compared between the two companies. Source: Fabozzi (2005)

Moody's	S & P	Summary Description
		Investment Grade
Aaa	AAA	Gilt edged, prime, maximum safety, lowest risk, and when sovereign borrower considered "default-free"
Aa1	AA+	
Aa2	AA	High-grade, high credit quality
Aa3	AA-	
A1	A+	
A2	A	Upper-medium grade
A3	A-	
Baa1	BBB+	
Baa2	BBB	Lower-medium grade
Baa3	BBB-	
		Speculative Grade
Ba1	BB+	
Ba2	BB	Low grade; speculative
Ba3	BB-	
B1		
B2	B	Highly speculative
B3		
		Predominantly Speculative, substantial Risk or in Default
	CCC+	
Caa	CCC	Substantial risk, in poor standing
Ca	CC	May be in default, very speculative
C	C	Extremely speculative
	CI	Income bonds - no interest being paid
D		Default

According to Moody's Credit Rating Prediction Model by Metz (2006) ratings are measures of through-the-cycle expected loss and should not therefore react to short term fluctuations. Metz (2006) states that due to the through-the-cycle nature of credit ratings they remain relatively stable over the cycles. Figure 2 illustrates the distribution of Moody's credit ratings over different rating categories. From the figure we can also observe the distribution of credit ratings between investment grade and speculative grade. According to Moody's approximately 40% of ratings are investment grade and 60% are speculative grade ratings.

Figure 2: Distribution of Bonds over Rating Categories

This figure shows the distribution of bonds over different rating categories. The dashed line in the figure shows the division between investment grade bonds and speculative grade bonds. Source: Moody's Credit Rating Prediction Model 2006



Even though the primary function of credit rating is to estimate the probability of default they may also turn out to be useful in many other ways. Many researchers (e.g. Elton et al. (2001) and Campbell Taksler (2003)) only study bonds categorized to certain categories. This type of method is also used in this study. The method is very helpful and helps the researchers to find the underlying differences between firms with different default probabilities. This way some group specific differences can be eliminated and the study sample can be made as homoskedastic as possible. The classification provided by the rating agencies is also used in this study to represent the differences between different rating categories.

3.1.4 Development of Credit Spreads in US

Changes in credit spreads are often related to uncertainties in the financial markets. When uncertainties occur in the financial markets, investors reallocate their funds from more risky assets to the safe havens such as US Government Treasury securities. This result into an increase in the corporate credit spreads. Figure 3 shows the development of corporate credit spreads of Baa bonds for time period 1998 to early 2007. As we can see from the figure the

financial crisis in 1998 which resulted from the default of Russia's government bonds and the collapse of the Long Term Capital Management created a spike in the credit spreads. After stock market peak of 2000 the spreads continuously continued to grow to early 2003. This is in line with the poor performance of the equity market during that time. In 2007 (not in the graph) the spreads again started to widen rapidly as a result of the prevailing credit crisis that begun at summer 2007.

Figure 3: Development of Credit Spreads 1998–2007

This figure shows the development of credit spread between average Baa Corporate Bond and 10-year US Treasury Bond from 1998 to 2007. Source: http://seekingalpha.com/article/31069-investors-starting-to-demand-greater-rewards-for-risk-taken

3.2 Structural Determinants of Credit Spreads

In this section we are going to look at the variables of the structural contingent-claim models, such as the Merton model, also known as the structural credit risk model. Collin-Dufresne et al. (2001) state that structural models of default[10] provide an intuitive framework for indentifying the determinants of credit spread changes. The authors continue that these

[10] Such as the models by Merton (1974), Black and Cox (1976) and Longstaff and Schwartz (1995)

models build the original insights of Black and Scholes (1973), who demonstrate that equity and debt can be valued using contingent-claims analysis. We will end this section by discussing the default probability in more detail because it is the core risk into which all of these structural determinants are related to.

3.2.1 Firm Leverage Ratio

In the heart of the corporate liability pricing model created by Merton (1974) is the firm leverage ratio. The theory states that the more leveraged a firm is the more likely it is that it phases the event of default. The structural framework suggests that default is triggered when the leverage ratio reaches a certain threshold level. This means that the closer the leverage ratio gets to the threshold, the more probable the event of default will come. Thus we can state that the credit spreads should increase as the leverage ratio of a firm increases.

Collin-Dufresne et al. (2001) used the change in firm leverage ratio as one of the explanatory variables on credit spreads. The firm leverage in their study was determined as book value of debt divided by the sum of market value of equity and book value of debt. The study showed that the relation between changes in firm leverage and credit spread was statistically significant with predicted sign. The authors also stated that the sensitivity to changes in leverage ratio tends to increase as leverage increases. By examining the spread changes of bond indexes Huang and Kong (2002) found that by using Moody's default rates as an explanatory variable on credit spread they found that the coefficients were of predicted sign, but statistically insignificant.

3.2.2 Spot Rate

The spot rate is the yield on a zero-coupon Treasury with the same maturity as the observation period. The spot rate is often referred as the basic interest rate in the economy. The relation between the spot rate and credit spread was studied by Longstaff and Schwartz (1995). They

state that in general, the price of a risky bond is a decreasing function of the spot rate. Furthermore they state that there exists a sensitivity of the price changes in the spot rate. The authors state that even though an increase in the spot rate results in a lower value of debt, an increase in the spot rate also implies that the upward drift of the risk-neutral process for the firm value is higher. This means that as the spot rate increases, the firm value is expected to drift away from the default limit at a faster rate, which reduces the risk-neutral probability of a default. In light of Longstaff and Schwartz (1995) we can thus make a statement that an increase in the spot rate should result into a decrease in the credit spread. In line with the theory of Longstaff and Schwartz (1995), Collin-Dufresne et al. (2001) were able to find that an increase in the risk-free rate lowers the credit spread for all bonds. Furthermore they found that the sensitivity to interest rates increases across leverage and rating groups.

Huang and Kong (2002) used the monthly changes in the Merrill Lynch Treasury Master Index yields, as the measure of changes in general interest rate. They found that interest rate variables only account for a small proportion of credit spread changes. However, this effect was found to be stronger on high yield bonds. Also the signs of all interest rate related coefficients were consistent with the intuition.

Another study that found a relation between the spot rate and credit spreads was done by Van Landschoot (2004). By using data from the European bond market, she found that there exists a negative relationship between changes in the level of interest rates and credit spread changes. The findings made by the academics mentioned refer to the fact that the spot rate plays an important role in credit spreads changes, both in theory and in practice.

3.2.3 Slope of the Yield Curve

Besides spot rate another interest rate related factor that has been claimed to have an effect on credit spreads is the slope of the yield curve. According to Litterman and Scheinkman (1991) the level and the slope of the term structure are of most important factors driving the term structure of interest rates. According to Collin-Dufresne et al. (2001) an increase in the slope

of the yield curve should result into a decrease in credit spreads. This is because the slope of the yield curve is often related to future business cycle conditions. Collin-Dufresne et al. (2001) interpreted slope of the yield curve as both an indication of expectations of future short rates, and as an indication of overall economic health. Despite the theoretical importance of the slope of the yield curve its actual importance in empirical researches has been debatable. Collin-Dufresne et al. (2001) failed to find statistically significant relation between the slope of the yield curve and the credit spreads. Moreover, they actually found that in short- and long-maturity subsamples the coefficients were of the opposite sign than expected. Huang and Kong (2003) also failed to find the slope of the yield curve to be an important driver in credit spread changes. Differing results, however, were found by Van Landschoot (2004) who in light of her results stated that with the spot rate the slope of the yield curve also is an important determinant of credit spreads changes.

3.2.4 Volatility

The famous Black-Scholes-Merton model shows that asset volatility is one of the inputs of the model to determine the value of corporate debt. Since debt is equivalent to a short position on a put option on firm's assets, it is easily understood why an increase in volatility is expected to reduce the value of debt and therefore increase the credit spread. The problem with the volatility of assets, however, is the fact that it cannot be measured directly. Collin-Dufresne et al. (2001) state that the best way to measure asset volatility would be to use the implied volatilities of firm's publicly traded options. Unfortunately this is also very difficult due to the fact that not all firms have publicly traded options. Thus, in their study of credit spread changes Collin-Dufresne et al. (2001) used implied volatility market volatility as one factor explaining the credit changes. The implied volatility that the authors use in their study is the Chicago Board Options Exchange Volatility Index (ticker symbol VIX). By looking at the later studies made on changes on credit spreads, it seems that using VIX as the proxy for asset liquidity has become an 'industry standard'. What VIX actually measures is the market expectations of near-term volatility of S&P500 index options.[11] The CBOE Volatility Index

---

[11] Source: http://www.cboe.com/micro/vix/introduction.aspx

has also been referred by some as the 'fear index' of financial markets.[12] In the light of the research made on the effect of VIX on the changes to corporate spreads it seems evident that volatility is an important driver of credit spreads. Collin-Dufresne et al. (2001) found that the VIX appears to have the greatest economic impact for short maturity bonds' credit spreads. When studying the relation between VIX and credit spread changes more carefully the authors find that the relation is asymmetric. This means that the increases in implied volatility dramatically impact credit spreads whereas decreases do not. The authors' findings were similar with the findings of Bekaert and Wu (2000) for stock returns. Huang and Kong (2002) and Van Landschoot (2004) both find a statistically significant relation between implied volatility and credit spread changes. Thus it seems that with the spot rate, in both theory and practice, the implied volatility seems to be of most important factors explaining the changes in credit spreads.

3.2.5 Jump in Firm Value

Jump in firm value is an extension of the original model of Merton (1974). The original model assumed that the asset price changes are continuous and thus jumps cannot happen. The experience from the financial markets, however, shows that asset prices are far from continuous and thus there would be a need for a jump model. Collin-Dufresne et al. (2001) state that changes in the probability and magnitude of a large negative jump in firm value should have a significant effect on credit spreads. Delianedis and Geske (1999) state that while jumps in firm value may explain some of the residual spread; it is unlikely that they can explain it entirely. The empirical results on the jump in firm value are not fully supporting the theory. Collin-Dufresne et al. (2001) did not find any explanatory significance for change in the probability and magnitude of jump when they used a model constructed from at- and out-of-the-money puts and at- and in-the-money calls on S&P 500 with short maturities. The proxy used by Collin-Dufresne et al. (2001) also reveals a problem on examining the jump factor. The problem is that it is impossible to directly measure the probability and expected size of a jump in firm value and thus proxies are always needed. Therefore by explaining the

---

[12] Source: http://en.wikipedia.org/wiki/VIX

possibility of a jump in firm value, one is always making assumptions about relation between the proxy and the true variable.

3.2.6 Recovery Rate

One important factor related to default rate is the recovery rate which is the proportion of dollars per par value that is received by a debt holder in case of default. Altman and Kishore (1996) showed that recovery rates of defaultable bonds are time varying. For example, for years 1978 to 1995 the average dollar recovery rate (per $100) of senior secured loans was 57.89 with a standard deviation of 22.99. This clearly shows that recovery rates are far from constant.

Collin-Dufresne et al. (2001) state that the expected recovery rate of a firm should be a function of the overall business climate. This means that if overall business climate works as a proxy for recovery rate, it should have explanatory power over changes in credit spreads. Collin-Dufresne et al. (2001) used the return on S&P500 as a measure for overall business climate. Their results show that the return of S&P500-index had a significant effect on credit spreads and that the effect was typically several times larger than on the firm's own equity return. The authors state that this is the first indication that monthly changes in firm-specific attributes are not the driving force in credit spread changes. From these results we can state that even though owning equity and debt both lead to a long position on firm's assets, firm's own equity returns are not necessarily the driving force behind the negative correlation between credit spreads and equity markets. This supports the choice of using S&P500 as a proxy for overall state of economy. However, one must remember that the correlation between S&P 500 and an individual stock is often relatively strong.

Although, according to Collin-Dufresne et al. (2001) the relation between the S&P500 and credit spreads is stronger than between individual stock returns and credit spreads, there is still evidence that individual equity returns and bond yields are statistically significantly correlated. Kwan (1996) examined the correlation between the returns on individual stocks

and the yield changes of individual bonds of the same company. He found that there is a significant negative correlation between changes in individual bond yields and the issuing firm's contemporaneous stock returns. In light of his findings the author states that firm-specific information tends to be embedded first into individual stock prices and then reflected in individual bond prices.

3.2.7 The Outcome of Structural Determinants – The Default Risk

The variables presented above all affect credit spreads through the probability of default, also known as the default risk. Theoretically the effect of default risk is extremely important. Elton et al. (2001) state that if there would be no taxes and if investors would be risk neutral then discounting the expected cash flows of a bond with the appropriate government spot rate would produce the same value as discounting the promised payments at corporate spot rates. Thus theoretically:

$$E(CF) \times e^{-r_G T} = CF \times e^{-r_C T}, \qquad (1)$$

where $e^{-r_G T}$ is the government spot discount rate and $e^{-r_C T}$ is the corporate spot discount rate. By using this assumption Elton et al. (2001) state that in risk-neutral world, the difference between corporate and government forward rates is given by

$$e^{-(r^C{}_{t+1} - r^G{}_{t+1})} = (1 - P_{t+1}) + \frac{aP_{t+1}}{V_{t+1T} + C}, \qquad (2)$$

where C is the coupon rate; P_{t+1} is the probability of bankruptcy in period $t + 1$ conditional on no bankruptcy in an earlier period (the marginal default probabilities); a is the recovery rate assumed constant in each period; r^C_{tt+1} is the forward rate as of time 0 from t to t+1 for

corporate bonds; r^{G}_{tt+1} is the forward rate as of time 0 from t to t + 1 for government (risk-free) bonds; and V_{t+1T} is the value of a T period bond at time t + 1 given that it has not defaulted in an earlier period. [13] According to Elton et al. (2001) this equation can be used directly to estimate the rate spread that would exists between corporate bonds and government risk-free bonds in a risk neutral world.

However, as in reality the investors are not risk neutral and therefore the explanatory power of the default risk has not been adequate to explain a large part of the credit spread. By using the Lehman Brothers Fixed Income Database from years 1987-1996 with over 95,000 bond months and their reduced form model Elton et al. (2001) state that the zero tax spread from expected default is small and does not account for a significant part (no more than 25%) of the corporate spread. By using a similar method to Elton et al. (2001) Delianedis and Geske (1999) found that the corporate default spreads on average are much smaller than the observed credit spreads.

By using a calibration approach based on historical default data Huang and Huang (2003) found that for investment grade bonds the credit risk only accounts for a small proportion of the credit spread on bonds with all maturities (typically around 20%), being even smaller on bonds with short maturities. For Baa (=BBB in Standard & Poor's) bonds they found that default risk generally explains around 30% of the credit spread. The calibration methods used in their study are all based on the general structure that the firm asset value evolves according to a diffusion process with a constant volatility plus a possible jump.[14] Huang and Huang (2003) also find that the explanatory effect of the credit risk is much stronger with speculative grade bonds.

Dionne et al. (2005) find slightly differentiating results compared to for example Elton et al. (2001). By using a simple discrete-time model for estimating the proportion of the corporate

---

[13] See the proof of the formula from Elton et al. (2001).
[14] See more about the processes from Huang Huang (2003).

credit spread attributable to default risk the authors find that default risk explains a lot larger part of the credit spread than the previous studies have shown. Say for A rated bonds the proportion jumps from 9% to 23% and for Baa bonds the proportion jumps from 32% to 65%. The authors note that these results are found on the high default cycle only and should not be generalized to all economic cycles. Even though the results that Dionne et al. (2005) find are somewhat different to previous studies they do not make any statements about the validity of their results. But then, what they do state is that the results found by previous studies do not hold for all periods of the default cycle. They also state that the estimations models used in basically all studies that focus on the credit spreads are very sensitive to changes. Thus a small change in e.g. the expected recovery rate can lead into a significant difference in the proportion that the default risk is able to explain.

As we have shown the studies done on the relation between the default risk and the credit spread have been giving parallel results even though being slightly differentiating. The study by Elton et al. (2001) is in many studies considered as the benchmark study of the explanatory power of default risk in credit spreads. Thus we conclude that the current theoretical consensus view of the subject is that even though in theory the default risk is the main driver in explaining the corporate credit spreads in real life, however, according to studies its proportion to credit spreads is only quite small. Thus in order to get a more complete view of the structure of credit spreads we must start looking new variables that are able to explain the credit spreads.

3.3 Credit Spread Puzzle

Credit spread puzzle refers to the empirical findings discussed above that default risk itself has been unable to entirely explain the credit spreads or their changes. For example Tsuji (2005) found that the structural variables explain on average only about 11% of the credit spread. Thus academics have started to discuss about 'credit spread puzzle' which aims to explain what are the other non-default related variables that are able explain credit spreads. Two rather comprehensible variables have been found: taxes and liquidity. The third,

systematic risk is a bit more courageous statement, even though it has some credentials to it. Now it's time to take a more thorough look to each one of these variables.

3.3.1 Taxation

Especially in the US, besides default risk, the most noticeable difference between government bonds and corporate bonds lies in the taxation differences between these securities. With corporate bonds the interest that an investor receives is subject to both federal and state income tax. The capital gains that an investor receives from holding corporate bonds are subject to investor's ordinary federal tax rate. However, if the corporate bonds were originally issued at discount then the capital gains are taxed as interest income. With US Treasury securities the tax treatment is different. The interest that an investor receives from US Treasury bills, notes and bonds is subject to federal tax income but is exempt from all state and local income taxes. With government discount instruments (e.g. T-bills and zero-coupon bonds) the discount on those instruments is also taxable only on the federal tax income.[15]

In a simplified manner these differences in taxation mean that investors have to pay less tax from the income earned from government bonds than from the income earned from corporate bonds. Theoretically this tax difference should be priced at the market and should therefore be reflected into the credit spreads.

Elton et al. (2001) estimated the effect of the taxation differences to credit spreads. Because there is no way to directly measure the size of tax terms, Elton et al. (2001) examined 11 different values of tax terms ranging from 0 to 10 percent. By using these tax rates they estimated the after-tax cash flows for each bond in every month in their sample. By using advanced mathematical procedures the authors found that an effective tax rate of four percent leads to the smallest mean squared pricing error and thus they decided to employ that rate in

---

[15] Source: US Department of the Treasury, Internal Revenue Service, Publication 550, Investment Income and Expenses (Including Capital Gains and Losses) 2007.

their later analysis.[16] Before Elton et al. (2001) taxes had been mostly ignored in academic research. However, Elton et al. (2001) found that taxes account for a significantly larger portion of the difference between corporate bonds and Treasury bonds than do expected default losses. As an example the authors give 10-year A-rated bonds. In their sample taxes accounted for 36.1 percent of the spread compared to the expected default loss which only accounted for 17.8 percent. The authors stress that state and local taxes are an important factor to be observed because they are paid on the entire coupon of corporate bonds, not just on the difference in coupon between corporate bonds and Treasury bonds.

As mentioned earlier the tax effect of corporate spreads has not been examined actively before Elton et al. (2001). Surprisingly despite the findings of Elton et al. (2001) the effect of taxes has not been researched actively to date. However, on the basis of the findings of Elton et al. (2001) we can state that the differentiating tax treatment between the US corporate bonds and Treasury bonds have an influence on the size of the credit spread. On the other hand we can conclude that even when the default risk and tax effect combined the explanatory power of these variables is not sufficient to explain the whole credit spread. Thus there must exist some other undetermined components of risk that are able to explain the spread on corporate bonds.

3.3.2 Liquidity

In the light of findings by Elton et al. (2001) and others we can make a statement that the credit spread consists of at least three components (default risk, tax effect, systematic risk). Outside these components we feel that there should be at least one more factor which may have a significant role in explaining the existence of the credit spread; liquidity.

---

[16] To go more into the mathematical procedures of the study see Elton et al. (2001).

The effect of liquidity to expected asset returns has been an active topic of research in the past few decades. Liquidity can be considered as a risk because if the security does not trade actively it can be difficult to for example hedge the risk or estimate a fair value for the security.

The seminal work of Amihud and Mendelson (1986) on the field of liquidity and asset expected returns was the first to show that investors require additional returns for additional liquidity risk. By using bid-ask spread as a proxy for liquidity Amihud and Mendelson (1986) showed that market-observed average returns on assets were an increasing function of the bid-ask spread. And thus shows that liquidity risk is compensated as higher expected returns. In the light of these findings we can state that because corporate bonds are much less liquid securities than Treasury bonds, investors may require an additional return for the additional risk related to liquidity.

Chen et al. (2005) tested this theory by assessing bond-specific liquidity for a large sample of corporate bonds and by examining the association between bond-specific liquidity estimates and corporate bond yield spreads. They found that depending on the liquidity measure, liquidity can alone explain as much as 7 percent of the cross-sectional variation in bond yields for investment grade bonds, and as much as 22 percent for speculative grade bonds. Thus it can be stated that liquidity costs are demonstrably higher for speculative grade bonds than for investment grade bonds. By using the bid-ask spread as the measure the authors found that one basis point increase in the bid-ask spread results to 0.42 basis point increase in the credit spread of investment grade bonds.

3.3.3 Systematic Risk

As we have shown, the current academic research have yet to have shown that default risk and tax premiums have not been able to sufficiently explain the credit spread (e.g. Elton et al. (2001) and Collin Dufresne et al. (2001)). This means that if the empirical studies have been correct we can state that there must be some other underlying risk to explain the credit

spreads. Elton et al. (2001) state that the third part of the credit spread is the risk premium. By this they mean that that the return on corporate bonds would be riskier than it is for government bonds and thus investors should require a premium for the higher risk. The authors' statement is that if corporate bond returns move systematically with other assets in the market (whereas government bond returns do not), then corporate bond expected returns would require a risk premium to compensate for the systematic risk component that cannot be diversified. This would be similar to any other asset that carries the so called 'market risk'. Elton et al. (2001) showed that there exists a correlation between expected default loss and equity returns and thus it can be said that there exists a systematic risk factor in corporate bonds. The results that the authors found were quite impressive. They show that by making use of the Fama-French factors, as much as 85 percent of that part of the spread that is not accounted by default risk or taxes can be explained as a reward for bearing the systematic risk.

3.4 Other Unspecified Variables

In additional to the default related variables and credit spread puzzle variables it is possible and to some extent even likely that there are other variables that explain credit spreads as well. One possible explanatory factor to credit spreads can be corporate governance and corporate ownership issues. After controlling for firm characteristics that prior research has shown to be related to credit ratings, Asbaugh-Skaife et al. (2006) found that credit ratings are positively related to degree of financial transparency of the company and to the overall independence of the board of directors. Klock et al. (2005) also examined the importance of corporate governance to bondholders. They found a negative relation between the corporate governance index and the cost of debt financing. Klock et al. (2005) also found that firms with the strongest takeover defenses (top quartile) are associated with a lower cost of debt financing, whereas firms with the weakest takeover defenses (lowest quartile) are associated with higher cost of debt financing. Thus it seems that firms having better corporate governance practices enjoy lower cost of debt financing i.e. lower credit spreads.

The relationship between bondholders and management ownership has also been studied. Asbaugh-Skaife et al. (2006) found that firm credit ratings are negatively associated with the number of blockholders that have at least a 5% ownership in the firm. Strock Bagnani et al. (1994) state that in theory when management ownership increases their incentives are to act in favor of shareholders. After reaching a certain point in ownership, the management however, becomes more risk averse and start to act more in to the interests of bondholders. This is actually what Strock Bagnani et al. (1994) were able to find. They found that there is evidence for a significant positive relation between managerial ownership stake and bond return premia in the management ownership range from 5 to 25 percent. They also found that there is some weak evidence for negative relation between managerial ownership and bond return premia, when the management ownership exceeds 25 percent.

In light of these findings it can be said that academics have found a wide range of variables that affect credit spreads. From these variables the structural variables based on the Merton model are implicitly the ones that explain the price of risky debt. The credit spread puzzle variables, on the other hand, are clearly related to market inefficiencies such as liquidity and taxes. The other variables are more or less related to transparency and agency problems within the firm and can be thus categorized into the variables related to market inefficiencies.

4. Hypotheses

In this chapter we are going to present the main hypotheses of the study. The main hypotheses (hypotheses 1–5) are based on the structural determinants of credit spreads based on the model by Merton (1974). We are also going to use two other macroeconomic hypotheses (hypotheses 6–7) to test whether these variables work as good better proxies for general state of the economy than hypothesis 5. In total this study consists of seven different hypotheses related to the explaining the change in credit spreads. The hypotheses are following:

Hypothesis 1: An increase in the spot rate results into a decrease in credit spreads.

Empirical evidence about this hypothesis was given by Longstaff and Schwartz (1995), who state that an increase in spot rate results to a higher risk neutral drift in firm value process, which reduces the probability of return. The authors showed that this effect is stronger than the opposite direction effect that result from a higher discount rate due to higher spot rate.

Hypothesis 2: An increase in the slope of yield curve decreases the credit spreads.

This hypothesis is related to the assumption that a decreasing yield curve slope can be interpreted as a sign for a weakening economy and vice versa. Also since an increase in the slope of the yield curve means that the expectations of future spot rate increase, which should lead to a decrease in credit spreads. This assumption is in line with the assumption of Collin-Dufresne et al. (2001). In relation with both *hypotheses 1* and *2* Huang and Kong (2003) state that high interest rates and steep yield curves are usually associated with expanding economy and low credit spreads.

Hypothesis 3: An increase in the implied volatility of the financial market results into an increase in credit spreads.

According to Merton (1974), holding debt of a firm results into a similar position as having a short position on a put option on firm's assets. Volatility is one of the key inputs in the Black-Scholes-Merton model, which implies that the value of the debt should be closely related to asset volatility. The theory implies that the higher the volatility of a security, the higher is the price of options on that security. Because debt is equal to being short on the option, the value of the debt should then decrease when volatility increases. Therefore we state the relation between credit spreads and implied volatility is expected to be positive.

We of course recognize that the implied volatility of S&P500 index options is not the same as the implied volatility of each firm's assets. Having implied volatilities of options from each firm in the sample would have been an ideal situation but unfortunately that kind of data was not available for this research. However, we feel that the CBOE implied volatility index is the best possible proxy for implied volatilities of the firm assets. The VIX index has also been used by for example Collin-Dufresne et al. (2001) and Huang and Kong (2002) as the proxy for company specific asset volatility.

Hypothesis 4: An increase in M&A activity increases the spreads of corporate bonds.

The corporate restructuring activity has not been used previously in studies related to corporate credit spreads. However, we feel that it has the potential to work as a proxy for the probability of a jump in the value of firm's assets. This is because corporate restructurings almost always create jumps in asset values (especially in the assets of target firms). Thus it is natural to think that at the times when M&A activity is high, credit spreads credit spreads would also be high because jumps in firm values become more likely.

There is another way to justify the role of M&A activity in explaining credit spreads. This is related to agency problems. The opinions on how a firm should operate may differ quite a lot between bondholders and managers. Where the managers (at least in theory) are maximizing the shareholder value, the bondholders' only interest is that the company meets the terms of the bond indenture, including the payment of interest and principal. Thus it can be stated that radical reorganizations etc. from the management are rarely in the interest of the bondholders. We believe that the M&A activity works also as a proxy for managers' risk aversion and would therefore also be reflected into credit spreads. Aggressive managers are not in favor of bondholders, which mean that when M&A activity increases, the credit spreads can also be expected to increase. This is despite the fact that majority of modern day bonds carry covenants to protect the bondholder.

Overall we feel that an increase in M&A activity increases the uncertainty of bondholders through the two mentioned channels, and thus has an increasing effect on credit spreads, and vice versa. This assumption is in line with Fabozzi (2005).

Hypothesis 5: An upgrade in business climate results into a decrease in credit spreads.

The S&P500-index is of most the worlds recognized stock index and is in our opinion therefore suitable to be used as a proxy of overall business climate in the US. This assumption is in line with Collin-Dufresne et al (2001).

However, we also realize that there may exist some natural positive correlation between stock returns and bond returns due to the fact that owning either one of these assets results into a long position in company's assets. According to Merton model, an increase in firm equity value (which is reflected to S&P 500 level) decreases the firm debt ratio (debt / assets) and thus moves the firm value process further away from the default threshold. In other words, when equity value rises the probability of default decreases. Due to this natural correlation between equity prices and debt prices we have two other variables in this study that are used as proxies for business climate: the consumer confidence index and the unemployment rate.

Hypothesis 6: An increase in consumer confidence decreases the credit spreads.

This hypothesis is similar to hypothesis 5 in a way that it is a broad macroeconomic indicator of the state of the economy. The consumer confidence index is widely recognized as one of the most important economic indicators in the United States. This is because the US economy relies heavily on consumer spending. According to the Economist consumer spending accounts for 70 percent of American demand[17]. Batchelor and Dua (1998) found that the consumer confidence index would have been able to predict the recession in US in 1991. However, they also state that due to the relatively small sample size the consumer confidence index has quite a lot of noise and is thus sometimes misleading. In light of these findings we state that a change in consumer confidence is a forecast of future uncertainty in the economy and works as a proxy for changes in business climate. Thus we believe that its changes should be reflected into credit spreads.

Hypothesis 7: An increase in unemployment rate increases the spreads of corporate bonds

This hypothesis is fully related to the fact that unemployment rate works as a proxy for the state of general economy. We feel that because the unemployment rate is one of the key indicators representing the state of the economy, an increase in the unemployment rate could be seen as negative news for the economy as a whole. This type of interpretation should thus also be reflected to the firms that are operating in the country. This is why we expect that an increase in unemployment rate will result into an increase in corporate credit spreads.

---

[17] Source: The Economist, *The Great American Slowdown*, April 12th-18th, 2008,

5. Data and Methodology

In this chapter we are going to present the data and methodology used in this study. In the first part of the chapter we are going to introduce some characteristics of the data and the sources from where the different types of data were collected. In the second part of this chapter we are going to present the methodology used in this study.

5.1 Data of the Study

5.1.1 Bond Data

The bond data used in this study to measure the changes in corporate credit spreads is monthly spread over benchmark yield curve data from US investment grade bonds which were part of the Dow Jones Corporate Bond Index during the time period of January 2003 to December 2007. The spread over benchmark yield curve data is calculated with linear interpolation and linear extrapolation methods by using the public US Treasury yields from same time period as benchmarks. The data for each bond was collected from Ryan Labs Inc. Asset Management database and the collected data for each bond is the following: issuer, coupon, maturity, market price, Moody's and S&P credit ratings, yield to workout date, modified duration and spread over benchmark yield curve.

The Dow Jones Corporate Bond index is built so that it constantly contains 96 investment grade bonds issued by leading US companies. The index changes constantly over time so that its requirements and characteristics (discussed later) are remained over time. The index is built so that it is designed to minimize the pricing and liquidity problems that are associated

with most corporate bond indexes.[18] Thus the bonds included in the index are of most liquid US corporate bonds that are traded.

The index contains only 'bullet bonds' which means that the bonds are not callable before maturity. The liquidity filter of the index is organized in a way that the minimum size of an issue taken to the index is $300 million. This way the small and the most illiquid issues can be eliminated. The structure of the index is constituted so that it gives the best possible general view of the development of US corporate bond market. This means that the bonds included in the index are also taken from different industries. The general structure of the index is so that it has equal weighting of bonds from financial industry, industrial industry, and utility industry. Table 2 shows the descriptive statistics of the index.

Table 2: Key Statistics of Dow Jones Corporate Bond Index

The table shows the most important descriptive statistics of the Dow Jones Corporate Bond Index. The bonds that are included in this index construct the sample that is used in this study. Source: Ryan Labs Inc. Asset Management, Structure Report, January 31, 2008.

Index Name	Number of Bonds	Market Value ($ billions)	Average Coupon	Yield to Workout date	Maturity	Modified Duration
Industrials	32	53.5	6.300	5.147	11.13	6.517
Financials	32	80.8	6.198	5.399	10.60	6.528
Utilities/Telecom	32	35.0	6.613	5.436	11.05	6.458
Total	96	169.2	6.370	5.328	10.93	6.501

As of January 31, 2008

By looking at Table 2 we can see what makes this dataset so attractive. First, the bonds are equally distributed to different industry classes. Second, the descriptive statistics of each industry are remarkably similar. The average coupons, yields, maturities and modified durations are all basically the same. This feature enables us later in this study to reliably look at the industry specific results, since we know that the sample is balanced thorough the observation period.

---

[18] Source: Dow Jones Corporate Bond Index, Fact Sheet, Dow Jones Companies 2007. Available online at www.dj.com

Table 3 shows how the bond portfolio is currently formed on basis of maturity. The administrator of the fund has stated that the maturity structure of the index is kept constant over time; this means that the bond sample in this study is diversified over time on both industries and maturities.

Table 3: Maturity Structure of Dow Jones Corporate Bond Index

This table shows how the bonds are distributed within different maturity cells in the bond index. Equal distribution between different maturity cells gives the sample a balanced overall maturity over the whole sample period. YTW = Yield (to workout date), CY = Current yield, Term = Termination to workout date, MDur = modified duration, Conv = Convexity. Source: Ryan Labs Inc. Asset Management, Structure Report, January 31, 2008.

Maturity Cell	% Portfolio	# Issues	Market Value ($ billions)	Coupon	Price	YTW	CY	Term	MDur	Conv
1.50 - 3.49	25.000	24	41.7	6.488	105.53	4.381	6.119	2.81	2.513	0.081
3.50 - 7.49	25.000	24	49.0	6.356	105.44	4.934	6.015	4.61	3.921	0.192
7.50 - 17.49	25.000	24	45.3	6.085	103.51	5.644	5.873	9.58	7.102	0.636
17.50+	25.000	24	42.8	6.554	102.50	6.351	6.389	26.71	12.468	2.427
Total	100.000	96	178,9	6.370	104.25	5.328	6.099	10.93	6.501	0.834

As of January 31, 2008

The bonds that are finally chosen into the sample used in this study must meet the following two requirements: First, each bond must have at least 10 month-end yield observations during the five year time period of the study. This way we have a more consisted view of the development of the bond spreads since the bonds that were in the index just for a short time are eliminated. Second, the issuer of the bond has to be from one of the industry categories mentioned (at some points in time the index also had bonds with other industry specifications, although only for short periods).

After the relatively easy screening process, due to the already commendable screening process made by the administrator of the index, we are left with 4465 bond months from time period from January 2003 to December 2007. This results to approximately 74 bond observations per each month.

5.1.2 Other Data

The credit rating data of the bonds used in this study is collected from Ryan Labs database. Since we use bond rating data from both Moody's and Standard & Poor's, we make a reasonable assumption that the two rating systems have the following one-to-one mapping Aaa = AAA, Aa = AA, A = A, Baa = BBB, Ba = BB, B = B. If the bond is rated by both Standard & Poor's and Moody's and the rating is not the same, we are going to use the more conservative rating to classify the bonds.

The mergers and acquisitions data used in this study is collected from SDC database. The purpose of the data is to illustrate the mergers and acquisitions activity in United States during the observation period. The data consists the number of completed deals where the target company has been from US and where the deal size has been at least $100 million.

The data to describe the implied volatility of the market is Chicago Board Options Exchange (CBOE) Volatility Index, which is a key measure of the implied near-term expected market volatility of S&P 500 index options.[19] According to CBOE, the CBOE Volatility index (Ticker: VIX) has been considered many to be the world's premier barometer of investor sentiment and market volatility. Due to the recognized role of VIX it is the best possible measure to be used in this study. The VIX data was provided to us by the Chicago Board Options Exchange.

As mentioned earlier we are using the returns of the S&P500 index as a proxy for the state of the business climate. The S&P500 data is monthly index level data and it is collected from the Datastream Thomson One Banker database.

---

[19] Source: http://www.cboe.com/micro/vix/introduction.aspx

The consumer confidence index is an index that is maintained by the US Conference Board. The index is built so that questionnaires are mailed to nationwide representative sample of 5,000 households of which roughly 3,500 typically respond. Each month, a different panel of 5,000 households is surveyed. The index data was collected from www.pollingreport.com.

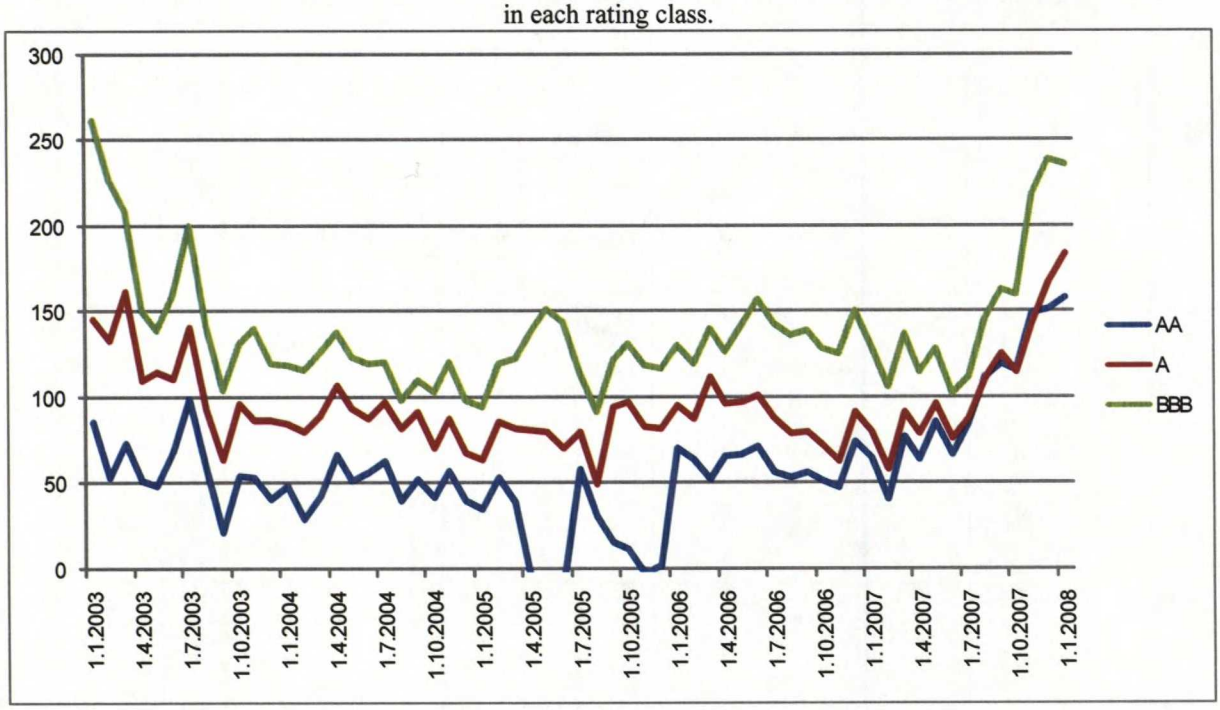
The unemployment data consists of monthly percentual unemployment rates in the US and it was collected from the monthly statistic releases of the U.S. Department of Labor, Bureau of Labor Statistics.

5.1.3 Descriptive Statistics of the Data

Figure 4 shows the spread differences between bonds rated to classes AA, A and BBB. Over the entire time period the average spread difference between the AA-rated bonds and the A-rated bonds was approximately 38 basis points. The equivalent difference between A-rated bonds and BBB-rated bonds was approximately 43 basis points. As the figure illustrates it can clearly be seen that when the credit spreads widen the yield differences between different bond categories are also widening.

Figure 4: Development of Credit Spreads in Different Rating Categories

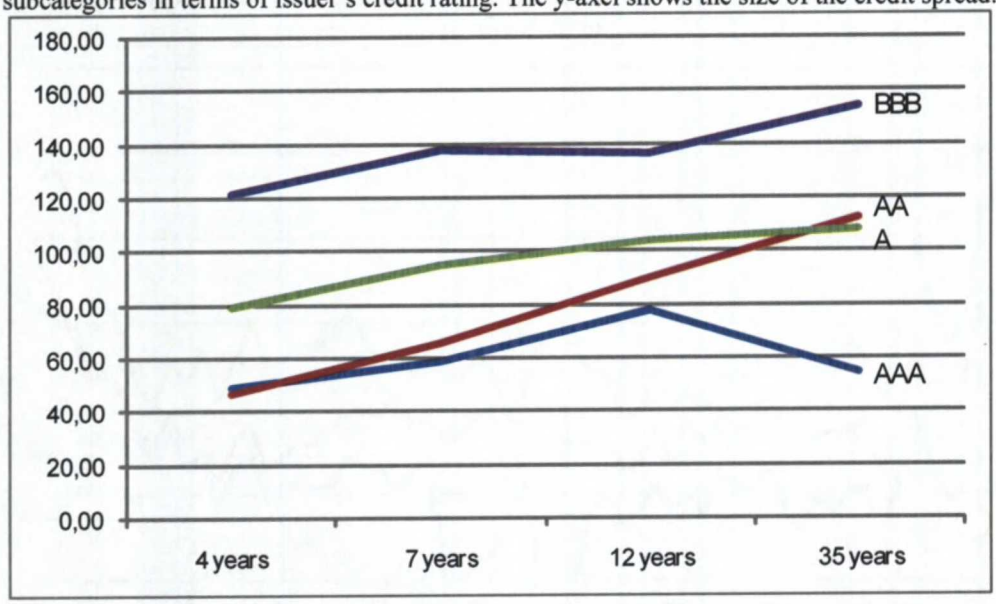
This figure shows the development of credit spreads in different rating classes during the sample period. The maturities of the bonds are not fixed so we make an assumption that the average maturity is approximately same in each rating class.



Another interesting way to describe the data is to take a look at the actual realized term structure of credit spreads in the sample period. As we showed earlier in section *3.1.2 Term Structure of Credit Spreads* the term structure should be increasing in maturity for high grade bonds and be humped shaped for lower grade bonds. Figure 5 shows the term structure of credit spreads in our bond sample.

Figure 5: Term Structure of Credit Spreads in Sample Data

This figure shows the term structure of credit spreads in our data. The total sample is divided into four subcategories in terms of issuer's credit rating. The y-axel shows the size of the credit spread.



From figure 5 we can see that in our sample the credit spreads are showing an increasing trend in practically every subcategory. One can also detect a humped shape especially from triple-A and single-A bonds. However, implication of the theory which states that the structure becomes more humped with lower grade bonds did not seem to hold very well in our sample.

5.2 Research Methodology

This section of the chapter is going to present the research methodology used in this study to explain the changes in credit spreads. We are going to provide an in depth view of the methods as well as of all the variables used in this study.

5.2.1 Variables of the Model

In this study we are going to use total of seven explanatory variables that are all directly related to our hypotheses. The variables that we are going to use in explaining the changes in credit spreads are: implied market volatility, S&P500 stock index, consumer confidence index, mergers and acquisitions activity, unemployment rate, yield on 10-year Treasury and the difference between 10-year minus 2-year Treasury yields. With these variables we can estimate the following regression:

$$\Delta CS_t^i = \alpha + \beta_1^i VIX_t + \beta_2^i SPX_t + \beta_3^i CCI_t + \beta_4^i M\,\&\,A_t + \beta_5^i UNEMP_t + \beta_6^i r_t^{10} + \beta_7^i slope_t + \varepsilon_t^i \quad (3)$$

Variable	Description	Predicted Sign
VIX_t	Implied volatility of S&P500 index options	+
SPX_t	Return on S&P500	-
CCI_t	Consumer confidence index	-
$M\,\&\,A_t$	Mergers and Acquisitions activity	+
$UNEMP_t$	Unemployment rate	+
r_t^{10}	Yield on 10-year Treasury	-
$slope_t$	10-year minus 2-year Treasury yields	-

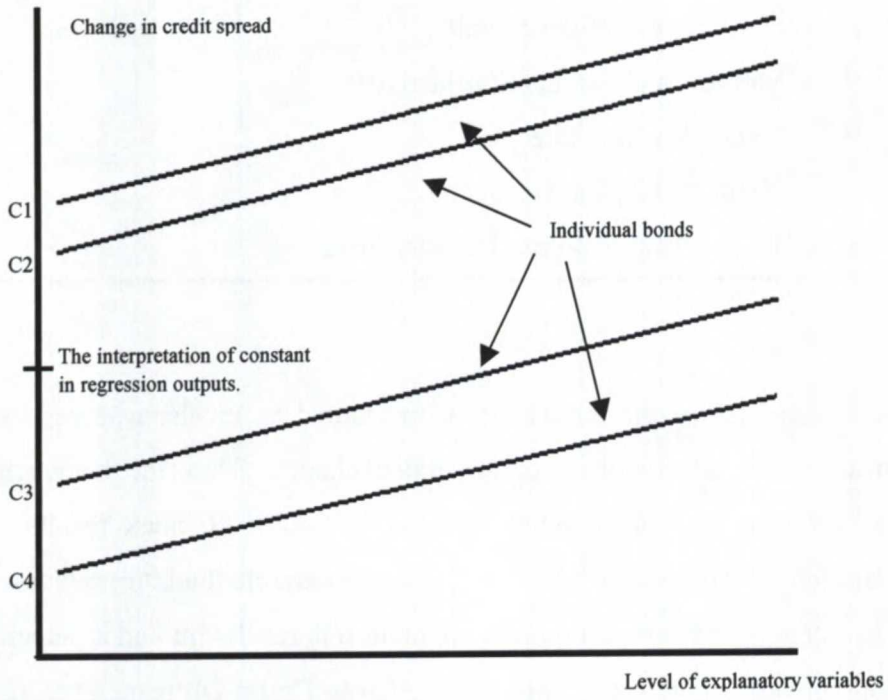
The explanatory variables of the model are all measured as levels, whereas the dependent variable is measured as continuously compounded change. Thus the interpretation of the coefficients is, for example: "a 50 point increase in S&P 500 index results into an x % decrease in corporate credit spreads". With interest rate variable the interpretation is the same: e.g. "a one percentage unit increase in unemployment rate results into an x percent increase in corporate credit spreads". This specification is similar to Collin-Dufresne et al. (2001) though they used changes instead of levels with explanatory variables. Whether we are using changes or levels in the regression does not affect the coefficients or the statistical significance of the

model. Instead it changes the interpretation of the coefficients. The reason why we are using levels instead of changes is that we feel that with these variables the levels are better understandable with common sense.

The constant, α (later referred as Constant in the regression outputs), of the model does not have a logical interpretation. In the fixed-effect OLS (explained more thoroughly in next section) the constant is unique for each dependent variable i.e. bond. Since each of the bonds in the model has its own constant the coefficient shown in the regression tables can only be interpreted as an "average" ordinate at the origin. The interpretation of the coefficient of the constant should not therefore be quantified, instead it should be considered as the variable that represents all the bond specific factors generating changes in corporate credit spreads.

Figure 6: Interpretation of Constant in the Regression Model

This figure illustrates the interpretation of the constant shown in the regression outputs. The four lines represent the changes of credit spreads in individual bonds. The horizontal axis describes all the explanatory variables of the model, whereas the vertical axis shows the change in credit spread. C1, C2, C3 and C4 are individual constants of the bonds. The horizontal line drawn to the vertical axis is the interpretation of the constant in the regression outputs.



5.2.2 The Regression Model

To study the explanatory power of our variables to credit spread changes we are going to use the ordinary least squares (OLS) regression method. By using OLS we minimize the sum of squares of the residuals, where the residual is the difference in the value between the plotted line and individual observation. The reason why we are using OLS-method is that it is far and away the most popular and uncomplicated application of regression analysis and it is widely used in similar studies such as Collin-Dufresne et al. (2001) and Huang and Kong (2002).

The OLS model that we use in estimating the effects of our explanatory variables on credit spreads is the fixed-effect OLS-regression model also known as Least Square Dummy Variable (LSDV). This model assumes a fixed constant for each bond in the sample, which best eliminates the natural bond specific factors. Due to the highly unbalanced panel data in our research, we feel that this kind of method captures the effect of the explanatory variables most efficiently. This method is also suitable for the study because the observation period of each bond is not on average very long. In fact the average amount of observations in the sample is 24.8 months.

5.2.3 Robustness of the Model

Due to the high unbalance of the data used in this study the fixed-effect OLS was by far the most suitable model to use. However, the drawback of the model is that because the fixed effect model creates a unique constant for each bond, the constant also captures the effect of firm specific variables, such as firm leverage ratio. Due to the nature of the data we therefore cannot study the effect of company specific variables in this study. However, we are going to use the leverage ratio, the credit rating and the industry to classify the bonds in order to discover whether the spreads of different types of bonds react differently into changes in macroeconomic variables. The constant included in the fixed-effect model has a very strong explanatory power because of the short average observation time of each bond. Due to these reasons and due to the fact that we are regressing absolute levels instead of changes in the measures we get a very high R-square. However, due to our diverging method the R-square

cannot be directly compared to the R-square of e.g. Collin-Dufresne et al. (2001) and Huang and Kong (2002). To make sure that the results showed in this study actually describe the true relation between the explanatory variables and the dependent variable, we have fixed the model from both heteroskedasticity and autocorrelation.

Because of the nature of our data we could not off-hand out rule the possibility of heteroskedasticity within our variables. Thus we ran a White (1980) test for heteroskedasticity and found that there in fact exists heteroskedasticity in the model. Due to our findings we are going to use White (1980) heteroskedasticity consistent covariance matrix estimator, which provides correct estimates of the coefficient covariances in the presence of heteroskedasticity of unknown form. The White covariance matrix is defined as follows:

$$\Sigma_w = \frac{T}{T-k}(X'X)^{-1}\left(\sum_{t=1}^{T} u_t^2 x_t x_t'\right)(X'X)^{-1}, \qquad (4)$$

where T is the number of observations, k is the number of regressors, and u_t is the least squares residual. The White covariance matrix adjusts the standard errors upwards to their right level so that we can see the true statistical significance of each variable.

To discover whether the dataset suffers from autocorrelation we ran Durbin-Watson test and found that the sample also suffers from autocorrelation. We fixed the autocorrelation by introducing a first-order autoregressive model. This model is also known as AR(1) and is specified as follows:

$$\begin{aligned} y_t &= x_t'\beta + u_t \\ u_t &= \rho_1 u_{t-1} + \rho_2 u_{t-2} + \ldots + \rho_p u_{t-p} + \varepsilon_t \end{aligned}, \qquad (5)$$

where ρ is the first-order serial correlation coefficient. In this study we estimate the AR term by using nonlinear model. This is done by extending the model described above into the nonlinear model:

$$y_t = \rho y_{t-1} + (x_t - \rho x_{t-1})'\beta + \varepsilon_t . \qquad (6)$$

By using this specification the Durbin-Watson statistic shows that the model is now free from severe autocorrelation and thus the results can be said to be trustworthy.

The corrections to heteroskedasticity and autocorrelation are all done with EViews 6, Standard Edition. All the regressions of this study also done with EViews 6, Standard Edition.

6. Empirical Results

In this chapter we are going to present the empirical results of this study. We are first going to look at the results by showing how the model is built. This way we are able to see which variables are statistically most important in explaining the changes in credit spreads and thus deserve to have their place in the regression. Then we are going to look at the results from four different perspectives: industry, firm leverage ratio, credit rating and bond maturity. After that we are going to look at the prevailing credit crisis in US markets and look at some statistics of how the macroeconomic variables have changed with the prevailing credit crisis. We are going to conclude this chapter by argumentation of the usefulness of the used model by making robustness checks.

6.1 Total Sample Regressions

To present the results we are first going to look which variables deserve their place in the regression. As mentioned earlier, the variables used are VIX, Spot Rate, Slope, M&A, SPX, CCI, and UNEMP. The Spot Rate is the 10-year treasury yield and the slope is the difference between the yields of 10-year treasury and 2-year treasury.

6.1.1 Relevant Variables of the Model

Table 4 shows the regression model from the total sample, constructed from the macroeconomic variables. We will first present the results by showing one variable at the time. Then we are going to show all the variables simultaneously to see the coefficients in the complete model.

Table 4: Regression Table with All Variables in the Study

This table shows the ultimate results of our study. The table shows both the multipliers and the p-values for each variable. Last two rows show the explanatory power of the model as well as the number of observations used in the model. The method used was Pooled Least Squares Method, with 194 cross-sections and 58 time observations after adjustments. The p-values of the regression are corrected with White (1980) model and the AR(1) was achieved after 11 iterations.

	1	2	4	5	6	7	8	9
Constant	4.014583	6.364472	4.580997	4.255545	4.315942	4.904845	5.063250	4.133584
Prob.	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0138**
VIX	0.029944							0.033100
Prob.	0.0014***							0.0001***
Spot Rate		-0.426623						-0.438308
Prob.		0.0011***						0.0002***
Slope			-0.108324					-0.249329
Prob.			0.2512					0.0202**
M&A				0.003356				0.003647
Prob.				0.1377				0.0381**
SPX					0.000128			0.000773
Prob.					0.8132			0.2245
UNEMP						-0.084337		0.207162
Prob.						0.6077		0.2367
CCI							-0.006031	-0.002480
Prob.							0.1452	0.5321
AR(1)	0.632589	0.684460	0.633886	0.658453	0.627375	0.637758	0.635271	0.662440
Prob.	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
R-squared	0.771264	0.776739	0.760368	0.762811	0.758114	0.763207	0.761539	0.804251
Observation	4465	4465	4465	4465	4465	4465	4465	4465

* Statistically significant with 10% confidence level

** Statistically significant with 5% confidence level

*** Statistically significant with 1% confidence level

From the table we can see that VIX and the Spot Rate are the only two variables that are able to statistically significantly explain credit spread changes by themselves. Both of these variables are of expected sign with 1% significance level. These two variables also remain statistically significant when all other variables are added to the equation. The explanatory strength of VIX and Spot Rate are supporting the contingent-claims-based approach first introduced by Black and Scholes (1973) and Merton (1974). The strength of the interest variable is in line with the extension of the model made by Longstaff and Schwartz (1995).

The findings are similar to the findings of Collin-Dufresne et al. (2001), Huang and Kong (2002) and Van Landschoot (2004).

The other variables themselves are unable to statistically significantly explain the credit spreads. However, we feel that some of those variables still truly belong to the model. In the regression where all variables are included we can see that all variables except for SPX are of expected sign. However, we feel that these results should be examined carefully because we are not sure whether all of these variables belong to the model. Therefore we will next focus on the variables' justification in the model. Because of the strength of VIX and Spot Rate in our study and also in the previous studies made on credit spreads, we feel that these variables belong to the model so strongly that they should be considered to be the two core variables of the model. Therefore we feel that in order to get the pure effect of the other variables we should control them with VIX and Spot Rate. This is what we do in Table 5.

The results shown in Table 5 strongly support the existence of the variables related to the structural determinants of corporate credit spreads. It shows that when controlled with VIX and Spot Rate, the Slope, M&A and SPX all gain statistical significance in explaining the credit spreads. We feel that this type of controlling is essential and well justified because in the light of the academic studies (including this) show that studying credit spreads without using volatility and interest rates is very dubious. By controlling the model with VIX and Spot Rate we are also able to find that the presence of UNEMP and CCI is not justified in the model. These variables prove out to be weaker proxies for general state of the economy than SPX and are thus left out from the regression in the further regressions.

Table 5: True Variables of the Model

This table shows the effect of the variables when controlled with VIX and Spot Rate. The method used was Pooled Least Squares Method, with 194 cross-sections and 58 time observations after adjustments. The p-values of the regression are corrected with White (1980) model and the AR(1) was achieved after 11 iterations.

	1	2	3	4	5	6	7
Constant	5.856423	6.007151	5.868959	4.447585	6.899320	5.787799	5.318063
Prob.	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
VIX	0.027382	0.032824	0.024347	0.034328	0.027994	0.027939	0.032500
Prob.	0.0030***	0.0009***	0.0087***	0.0000***	0.0030***	0.0016***	0.0001***
Spot Rate	-0.406078	-0.409148	-0.461492	-0.426638	-0.414488	-0.410241	-0.471052
Prob.	0.0021***	0.0006***	0.0002***	0.0006***	0.0025***	0.0029***	0.0000***
Slope		-0.229977					-0.158935
Prob.		0.0022***					0.0762*
M&A			0.004281				0.003644
Prob.			0.0226**				0.0386**
SPX				0.001123			0.000534
Prob.				0.0182**			0.3712
UNEMP					-0.198207		
Prob.					0.1156		
CCI						0.000801	
Prob.						0.8408	
AR(1)	0.695873	0.646574	0.706377	0.647075	0.650371	0.693637	0.655639
Prob.	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
R-squared	0.787423	0.795717	0.795493	0.792888	0.789346	0.787471	0.802471
Observations	4465	4465	4465	4465	4465	4465	4465

* Statistically significant with 10% confidence level

** Statistically significant with 5% confidence level

*** Statistically significant with 1% confidence level

6.1.2 Regression Results in the Total Sample

In this section we are going to look at the interpretation of the variables in the model. We are going to start from VIX and move down in the table all the way SPX.

As discussed earlier the VIX index is an extremely strong variable to explain changes in corporate credit spreads. The coefficient of the VIX implies that one point increase in the VIX

index leads to an average of 3.25% increase in credit spreads. This relation is considerably strong since the index value of VIX was 27.62 at the end of 2007. The monthly standard deviation of VIX during the observation period was 30% which means that the VIX index really swings the spreads even on a monthly level.

The variable with strongest explanatory power in our model was the Spot Rate. With p-value of 0.0000 it can be said that general interest rate level plays an important role in explaining the changes of corporate bond yields through both the base rate and the credit spread. The coefficient of Spot Rate indicates that a 0.1 percentage unit increase in the Spot Rate decreases credit spreads on average by 4.7%.

The importance of interest rates does not restrict only to the general level of interest rates but also to the slope of the yield curve. With p-value of 0.0762 (statistically significant at 10% level) the slope of the yield curve indicates that when the yield difference between 10-year treasury and 2-year treasury increases by one percentage unit the credit spreads decrease on average about 16%. Thus expectations about the future level of interest rates also play an important role in explaining the changes in credit spreads. This finding is in line with the contingent-claims pricing theory and the findings of Van Landschoot (2004).

This study is the first study to use M&A activity in explaining changes in corporate credit spreads. Earlier we argued that it belongs to the model due to its ability to work as a proxy for a probability of a jump in firm value as well as a proxy for management risk aversion. We find that at 5% statistical significance, an increase in M&A activity increases the corporate credit spreads. This finding is in line with the claims of Collin-Dufresne et al. (2001) and Delianedis and Geske (1999). The coefficient of M&A activity implicates that a monthly increase of 10^{20} M&A deals results into 3.6% increase in credit spreads. This seems

---

[20] During the observation period there was approximately 64 M&A deals announced each month in the US. The monthly standard deviation of the number of deals for the observation period was 26.7%.

reasonable since the probability of a price jump can be considered to be quite small even in the most active times of corporate restructurings.

The results found on the explanatory power of SPX are quite interesting. First, the SPX lost its statistical significance in the model when M&A activity and the Slope were included in the model. And second, its coefficient is of opposite direction than expected by theory which states that S&P500 works as a proxy for changes in the business climate and thus increases in S&P500 should lead to narrower credit spreads. This result may be due to the relatively large negative correlation between SPX and Slope. One other possible reason for the unexpected result is the fact that years 2003-2007 were strong bull years in the equity markets where the S&P500 enjoyed a rapid and somewhat stable growth. In fact during the 60 month observation period there was only five months during which the index declined more than 3 percent. Thus, differentiating results may have been found with longer observation period.

We feel that UNEMP and CCI also deserve few thoughts even though they were discarded from the model. Despite their inability to explain changes in credit spreads (whether controlled with VIX and Spot Rate or not) both of these variables show as expected signs and thus may have some relation to changes in credit spreads. However, the p-value of CCI is 0.8408 which indicates that its result is most likely due to pure coincidence. The p-value of UNEMP rate is 0.1156 which means that we failed to reject the null-hypothesis at 10% significance level. In the light of these results we state that CCI is most likely insufficient variable to explain corporate credit spreads. However, we do not presume that the unemployment rate would have no relation to corporate credit spreads and thus suggest further research on them.

6.2 Group Specific Regressions

In this section we are going to present the results from four different perspectives: industry, maturity, rating and leverage ratio. This way we are able to discover whether bonds with differing characteristics respond differently to changes in macroeconomic variables.

6.2.1 Maturity

We feel that an important classification factor in credit spreads is the bond maturity. This is because as maturity decreases, the interest rate risk and default risk decreases. This makes bonds with short maturities often less risky than the bonds with long maturities. In this study, however, we are more interested about is there any difference in how the spreads of the bonds with short maturities react to macroeconomic variables compared to the spreads of bonds with longer maturities. Table 6 on the next page shows the regression results divided into four different maturity groups. The maturity groups are: 0–5 years, 6–10 years, 11–20 years and over 20 years. By looking at Table 5 we are able to examine the effect of maturity on credit spreads. This interesting since it shows how investors with different investment horizons react to changes in macroeconomic variables.

Table 6: Regression Results by Maturity

This table shows the regressions where the sample is divided in terms of bond maturity. The total sample is divided into four subgroups in terms of maturity. The last column shows the regression for the total sample. The method used was Pooled Least Squares Method, with a total of 194 cross-sections and 58 time observations after adjustments. The p-values of the regression are corrected with White (1980) model and the AR(1) was achieved after 11 iterations.

	Maturity				
	0 - 5 years	6 - 10 Years	11 - 20 Years	20+ Years	Total Sample
Constant	4.877585	4.811006	4.583813	5.892083	5.318063
Prob.	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
VIX	0.049030	0.035278	0.027071	0.020307	0.032500
Prob.	0.0003***	0.0000***	0.0000***	0.0278**	0.0001***
Spot Rate	-0.620125	-0.347463	-0.227722	-0.496250	-0.471052
Prob.	0.0000***	0.0001***	0.0024***	0.0008***	0.0000***
Slope	0.053250	0.009384	0.032267	-0.470390	-0.158935
Prob.	0.5476	0.8873	0.5455	0.0000***	0.0762*
M&A	0.005616	0.002367	0.001784	0.002839	0.003644
Prob.	0.0240**	0.1012	0.1730	0.1934	0.0386**
SPX	0.000614	0.000437	0.000415	0.000715	0.000534
Prob.	0.3210	0.3387	0.2313	0.2322	0.3712
AR(1)	0.415283	0.568218	0.499126	0.639153	0.655639
Prob.	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
R-squared	0.730178	0.781953	0.833963	0.837703	0.802471
Observations	974	1407	791	1293	4465

* Statistically significant with 10% confidence level

** Statistically significant with 5% confidence level

*** Statistically significant with 1% confidence level

Table 6 shows that the effect of VIX-index is far from constant over different maturity groups. In the light of these results it seems clear that investors with longer investment horizons are not so bothered about the changes in VIX, since both its coefficient and probability decline when the maturity increases. However, we can still see that the VIX remains statistically significant in all maturity groups. This finding supports the general wisdom which states that investors with long investment horizons should not put too much stress on short term market fluctuations. The coefficient of VIX is less than half for the longest maturity group compared to the shortest maturity group. These results are similar to what Collin-Dufresne et al. (2001) found.

As we showed earlier the level of interest rate has the most significant explanatory power over the changes in credit spreads in the total sample. The strong explanatory power also holds in all maturity groups. In every group the relation between the 10-year treasury yield and the credit spreads remains negative as expected. What is interesting though is that the Spot Rate seems to have a larger effect on bonds with short and long maturities than on bonds with medium maturity. This finding is similar to Collin-Dufresne et al. (2001) as well as Huang Kong (2003), although the differences are much larger in our results than in the mentioned studies.

The slope of the yield curve reveals an interesting finding. As we can see from Table 5 the slope of the yield curve has no explanatory power over the bonds belonging to maturity groups shorter than 20 years. Though the sign is negative in each maturity group, we can clearly observe that the explanatory strength of the slope of the yield curve comes directly from the long term bonds. As much as we would like to state that the slope of the yield curve is, with certainty, a strong driver for credit spreads, we must also be skeptic and think whether there might be something build into our model that explain this behavior, and yet there might be. As was explained in Section 5.1.1 the credit spreads have been estimated by using linear interpolation method. The longer the maturity of the bond is the less accurate the estimated credit spread becomes. We will discuss this in more depth in section *6.4 Robustness Check and Limitations of the Model*.

The mergers and acquisitions activity also reveals an interesting finding. Even though the variable is statistically significant in the total sample, it is statistically significant (at 5% confidence level) only in the shortest maturity group. This implies that the effect of M&A activity differs between maturity groups. This can also be seen by looking at the coefficients. In the shortest maturity group the coefficient is clearly larger than in the three other samples with longer maturities. This implies that investors holding short maturity bonds are relatively more worried about the jump risk and change in management risk aversion than the holders of longer term bonds. This statement, however, is just an implication of the regression results and cannot be therefore reliably confirmed in our study. Thus we will not state that the maturity of the bond would have an unambiguous effect on the changes in M&A activity.

The effect of SPX is similar to VIX, though not as strong. The coefficient declines when maturity increases, which means that short term fluctuations in stock markets are not as important for long term debt holders as they are for short term debt holders. However, the p-values of SPX remain above 0.10 in all subsamples which indicates that there is a strong possibility that the results are only trivial.

6.2.2 Industry

As mentioned, our data consists of bonds from three different industries: industrial, finance and utility. The data in our sample is consisted so that in each one of these industry groups, there are bonds from all maturity categories and from different credit rating categories. Thus we believe that by making industry-specific regressions we are able to reliably capture the industry-specific factors affecting the credit spreads. Table 7 shows the industry specific regression results.

Table 7: Regression Results by Industry

This table shows the regression results in different industry groups. The industry classifications are based on the classifications made by Ryan Labs Inc. who is the administrator of the sample index. The method used was Pooled Least Squares Method, with a total of 194 cross-sections and 58 time observations after adjustments. The p-values of the regression are corrected with White (1980) model and the AR(1) was achieved after 11 iterations.

	Industry			
	Finance	Industrial	Utility	Total Sample
Constant	5.078855	5.310980	5.521066	5.318063
Prob.	0.0000***	0.0000***	0.0000***	0.0000***
VIX	0.037008	0.033372	0.026528	0.032500
Prob.	0.0001***	0.0002***	0.0007***	0.0001***
Spot Rate	-0.548484	-0.465167	-0.377787	-0.471052
Prob.	0.0000***	0.0001***	0.0001***	0.0000***
Slope	-0.141269	-0.170772	-0.158448	-0.158935
Prob.	0.1847	0.0319**	0.1042	0.0762*
M&A	0.004069	0.003646	0.003154	0.003644
Prob.	0.0644*	0.0347**	0.0340**	0.0386**
SPX	0.000842	0.000513	0.000216	0.000534
Prob.	0.2256	0.3323	0.7346	0.3712
AR(1)	0.628232	0.615312	0.749562	0.655639
Prob.	0.0000***	0.0000***	0.0000***	0.0000***
R-squared	0.794932	0.804941	0.807502	0.802471
Observations	1571	1528	1356	4465

* Statistically significant with 10% confidence level

** Statistically significant with 5% confidence level

*** Statistically significant with 1% confidence level

At first sight it seems that there are no significant differences on how the credits spreads react to changes structural determinant variables between industry groups. However, some interesting differences can be discovered. First, the financial industry seems to be more concerned about the volatility in financial markets than the industrial sector and the utility industry. Though the difference at first does not seem to be large, but say a four point change in VIX index (there was a total of 9 over four point monthly changes in the index during the observation period) increases the spreads on financial industry for about 14.8 percent, where as the equivalent increase in utility sector is only about 10.6 percent. Thus the differences in VIX index should not be considered to be unimportant.

Another interesting industry specific difference is in the interest rate level of the economy. The effect of interest rate level changes is much stronger in financial industry than it is for industrial or utility companies. In financial industry a one percentage unit increase in 10-year treasury yield results into a massive 55 percent decrease in credit spreads. This kind of event, however, is extremely rare, since it did not occur once in our whole observation period. Thus the coefficients would be better interpreted as "10 basis point increase in 10-year treasury yield results into a 5.5 percent decrease in credit spreads. The equivalent change in spreads for industrials is 4.7 percent and 3.8 percent for utilities. The difference here may be a result of high leverage ratios of financial institutions or just the fact that banking business in general is very closely tied to interest rate levels. The other variables also indicate that the financial services industry is more sensitive to changes in the variables than the firms working in utility industry or industrial industry.

6.2.3 Credit Rating

Next we are going to present the results based on credit ratings. In this part we are able to see whether the default risk set by rating agencies has an effect on how the variables influence the credit spread changes. Table 8 shows the regression results where the total sample is divided into four subcategories by credit ratings.

Table 8: Regression Results by Credit Rating

This table shows the regression results by issuing firm's credit rating. The credit ratings are provided by Standard & Poors and Moody's. If the credit ratings differ between the two rating firms the more conservative rating is used. The method used was Pooled Least Squares Method, with a total of 194 cross-sections and 58 time observations after adjustments. The p-values of the regression are corrected with White (1980) model and the AR(1) was achieved after 11 iterations.

	Credit Rating			
	AAA-AA	A	BBB	Total Sample
Constant	5.550713	4.900176	5.556651	5.318063
Prob.	0.0000***	0.0000***	0.0000***	0.0000***
VIX	0.029425	0.041982	0.023599	0.032500
Prob.	0.0017***	0.0001***	0.0007***	0.0001***
Spot Rate	-0.457346	-0.660056	-0.304488	-0.471052
Prob.	0.0000***	0.0000***	0.0000***	0.0000***
Slope	-0.162573	-0.136865	-0.127382	-0.158935
Prob.	0.0651*	0.2191	0.1562	0.0762*
M&A	0.002803	0.005984	0.002395	0.003644
Prob.	0.0704*	0.0257**	0.0357**	0.0386**
SPX	0.000444	0.000998	0.000123	0.000534
Prob.	0.4886	0.1270	0.8603	0.3712
AR(1)	0.705711	0.574451	0.804742	0.655639
Prob.	0.0000***	0.0000***	0.0000***	0.0000***
R-squared	0.815056	0.663687	0.852723	0.802471
Observations	1623	1162	1680	4465

* Statistically significant with 10% confidence level

** Statistically significant with 5% confidence level

*** Statistically significant with 1% confidence level

A peculiar finding from Table 8 is the behavior of A-rated bonds compared to AAA-AA and BBB-rated bonds. We can see that A-rated bonds react more strongly to both changes in VIX and Spot Rate. However, the R-square is much lower with A-rated bonds than for the other rating groups. It is also worth mentioning that the slope of the yield curve seems to have some statistical significance with only AAA-AA-rated bonds. The relative similarity between the credit rating groups is quite similar to what Collin-Dufresne et al. (2001) found.

6.2.4 Leverage Ratio

The final aspect from which we are going to look at the changes in credit spreads is the company's leverage ratio. Leverage ratio is often related to credit rating and naturally there is a correlation between credit rating and leverage ratio. Table 9 shows the regressions where the sample is divided into three subsamples according to company's leverage ratio.

Table 9: Regression Results by Leverage Ratio

This table shows the regression results sorted by the issuer's leverage ratio. The leverage ratio is measured as the proportion of book value of debt to book value of assets. The method used was Pooled Least Squares Method, with a total of 194 cross-sections and 58 time observations after adjustments. The p-values of the regression are corrected with White (1980) model and the AR(1) was achieved after 11 iterations.

	Leverage Ratio			
	0-20%	20-40%	40+%	Total Sample
Constant	4.996782	5.527506	5.449855	5.318063
Prob.	0.0000***	0.0000***	0.0000***	0.0000***
VIX	0.038178	0.032201	0.028564	0.032500
Prob.	0.0000***	0.0001***	0.0011***	0.0001***
Spot Rate	-0.589204	-0.454034	-0.421702	-0.471052
Prob.	0.0000***	0.0001***	0.0000***	0.0000***
Slope	-0.173474	-0.186059	-0.145432	-0.158935
Prob.	0.1085	0.0565**	0.1283	0.0762*
M&A	0.004851	0.003249	0.002715	0.003644
Prob.	0.0404**	0.0693*	0.0648*	0.0386**
SPX	0.000920	0.000372	0.000506	0.000534
Prob.	0.1491	0.5503	0.4494	0.3712
AR(1)	0.617579	0.708384	0.709455	0.655639
Prob.	0.0000***	0.0000***	0.0000***	0.0000***
R-squared	0.693343	0.790830	0.834346	0.802471
Observations	1250	1683	1532	4465

* Statistically significant with 10% confidence level

** Statistically significant with 5% confidence level

*** Statistically significant with 1% confidence level

Collin-Dufresne et al. (2001) found that firms with high leverage ratios are more sensitive to changes in market volatility. Our results, surprisingly, show quite the opposite. This is hard to justify with theoretical explanations since common sense says that firms with higher leverage

should be more sensitive to changes in volatility. One possible explanation for these findings is the fact that we used book values when determining the leverage ratio, whereas Collin-Dufresne et al. (2001) used market value of equity and book value of debt. An interesting finding, however, comes from the M&A variable, which states that companies with low leverage ratios are more sensitive to changes in M&A activity. This is rational since one may argue that firms with low leverage ratios are often targets of M&A deals and thus their possibility of a jump in firm value may be stronger than for firms in other leverage groups.

6.2.5 Final Thoughts About Results

To conclude the findings of this study we state that VIX and Spot Rate have maintained their position as the most significant explanatory variables on credit spread changes. The slope of the yield curve also shows statistical significance in the total sample, but when the sample was divided in terms of maturity results revealed that the long maturity group was the only group where the Slope showed statistical significance.

An interesting finding was the M&A activity which gave logical and statistically significant results in basically every subgroup. This indicates that though M&A activity has not been used in previous studies, it clearly has explanatory power over corporate credit spreads. Its ability to work as a proxy for firm value jump possibility and management risk averseness would be an interesting field for further research.

Even though SPX was unable to give statistically significant results in our sample, it still showed that it has stronger explanatory power than UNEMP or CCI both with and without controlling the variables with VIX and Spot Rate. This indicates that it is arguable to maintain SPX in the regressions to work as a proxy for business climate.

6.3 Unusual Circumstances – The US Credit Crunch

In this section of the chapter we are going to look whether the results founded in previous sections could also be extended to unusual crisis situations. Intuitively this is interesting, since the macroeconomic theories do not necessarily always hold in extreme situations. We are first going to give a briefing into what the current financial crisis is about and what are the underlying causes behind it. Then we are going look at the changes in our variables in the last few months of our sample period in order to study how the macroeconomic factors behaved before and during the crisis.

6.3.1 The Background of the Crisis

In this section we are briefly going to go through the fundamental factors that caused the crisis in the US credit markets. The purpose of this section is not to study all aspects of the situation just to familiarize the reader of some of the most important facts in order to better understand what has been going on lately on the credit markets.

The credit crunch in United States started to come alive when bad news about the default rates of subprime mortgage loans started to spread into the economy. The reason why the subprime mortgages were failing was that bank managers had been given loans to people with poorer and poorer solvency. In August 4, 2007, the Economist[21] stated that the bank executives will be haunted by *NINJA* loans (that stand for loans given to people with No Income, No Job or Assets). The crisis escalated because the cheap introductory rates that had been given to these *NINJA* borrowers started to expire and people had to start paying the much higher market rates for their debt. According to the Economist another reason for the credit crisis was that investors had been doing positive carry trades with subprime loans without really considering that higher yield means also higher risks. In the few preceding years before the crisis, the

[21] Source: "Investors sail into a credit storm amid worries about the debt markets", the Economist, August 4, 2007

default rates of subprime loans had been low, which in some how clearly blurred investors' eyes for the potential problems ahead.

When the subprime worries started to spread over the financial markets, it felt that at least at first, the market response to these poorly performing subprime loans was not extremely negative. This was most probably because the subprime mortgage market is not very large on global terms and because at that point investors believed that the ownership of these loans would have been widely scattered among investors, and would not therefore result to any drastic events. However, the truth was quite the opposite. In June 2007 two hedge funds ran by Bear and Stearns were found to have huge losses on subprime-backed securities. Not later than August, the French bank BNP Paribas had to suspend withdrawals from its funds due to the vanishing liquidity on the subprime market. After these announcements the investors started to think that the banks may be heavily exposed to the subprime mortgages. Due to the liquidity problems on certain parts of US securities markets the Federal Reserve had to intervene. What Fed did was it cut the discount rate, at which banks with liquidity problems can borrow from the central bank. It also made the discount window longer so that the banks could borrow for longer periods of time. Even though these actions helped the market to keep functioning they did not help the banks from making losses on subprime loans. To date, the subprime losses for world's leading banks have been tremendous: UBS $37 billion, Citigroup $21 billion, Merrill Lynch $22 billion and Morgan Stanley $9.4 billion, to name just the few.[22] On March 24, 2008, the Economist stated that it is possible that we are dealing with the most dramatic banking crisis in the US since the second world war, and that the crisis can be in some extent compared to the banking crisis in the Nordic countries in the early 1990's.

Even though the banking crisis started from sub-prime mortgage loans, its effects have spread to entire US economy. The shortage of liquidity and the mass of uncertainty were not present only in mortgage loans but also in corporate loans and interest rate markets. As we have showed earlier in this study (*5.1.3 Descriptive Statistics of the Data*) the corporate credit

---

[22] Source: BBC: Timeline: Sub-prime losses, How did the sub-prime crisis unfold?, http://news.bbc.co.uk/2/hi/business/7096845.stm

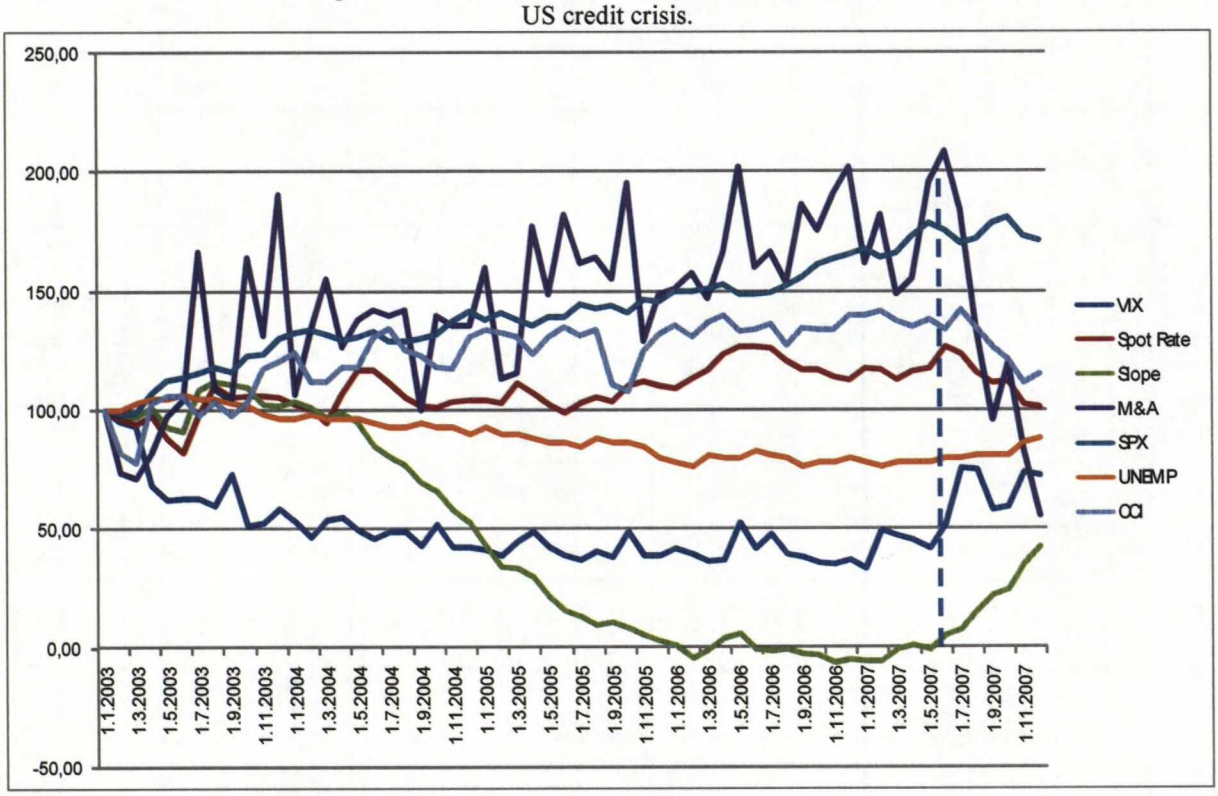
spreads started to widen heavily after the depth of the crisis finally started to unveil in July 2007. The true scale and time period of the credit crisis in US is still unknown and thus our dataset is unable to show the full effects of it. However, we are able to show if the macroeconomic factors had explanatory power in the first six months of the crisis compared to the times before the crisis.

6.3.2 Changes in Structural Determinants Due to Credit Crisis

In order to be able to understand what has happened in the US credit markets it is worth giving a look to how the structural variables have changed due to the crisis. Figure 7 shows all the variables used in this study indexed to 100 points in January 2003. Figure 8 shows the average credit spreads in the sample during the observation period.

Figure 7: Development of Explanatory Variables over the Study Period

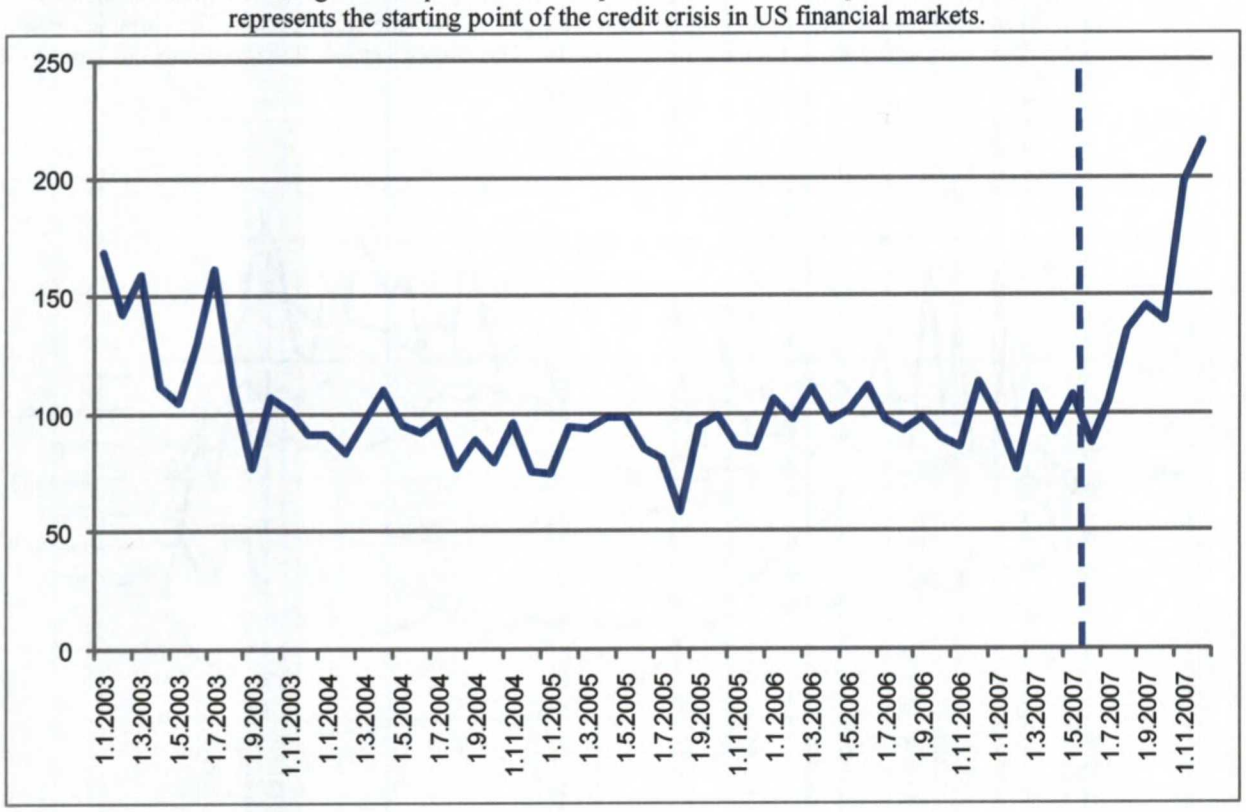
This Figure illustrates how the explanatory variables have changed over the study period. The variables have been indexed so that the starting value for each variable is 100. The dashed vertical line represents the start of the US credit crisis.



The dashed vertical line in Figure 7 represents the starting point of the credit crisis. Of course it is impossible to say when the crisis exactly started but we feel that even though the threats we present already on early 2007, it was not until summer 2007 when the world started to understand the severity of the crisis. Unfortunately we are unable to present the results by using regressions since the observation period for the crisis would be so short. However, what we are able to do is to make descriptive considerations from the data. As one can see from Figure 7, every variable used in this study changed significantly in the last 7 or so months of the observation period. An interesting finding is that all except M&A activity changed to the direction proposed by the contingent-claims-based debt valuation method. This implies that in extreme conditions, M&A activity works more as a proxy for management risk aversion than as a proxy for firm value jump probability. Another interesting finding is the fact that based on Figure 7 it seems that the equity market variables (VIX & SPX) were the once that changed the least due to the crisis.

Figure 8: Average Sample Credit Spread During the Observation Period

This table shows the average credit spread in the sample for the observation period. The vertical dashed line represents the starting point of the credit crisis in US financial markets.



6.4 Robustness Check and Limitations of the Model

In order to show that the results shown in this study are valid, we will go through some of the issues that either give credibility to the model or limit the models ability to give unbiased results.

6.4.1 Time Period of the Study

The five year observation period of this study has both pros and cons. Thanks to the relatively short time period we were able to state that the results shown in this study are relevant today and are not influenced by the relation between the variables decades ago. On the other hand the shortness of the time period imposes certain problems. This is especially because the explanatory variables used in this study are all macroeconomic variables. When constructing studies with macroeconomic data it would be optimal to have a time period of at least one business cycle. In this case it would have meant that the time period of this study would have been a few years longer. Unfortunately due to the relatively short history of Dow Jones Corporate Bond Index this kind of arrangement was not possible. Another problem that arises from the relatively short time period and the lack of over-the-business-cycle data is the fact that there are only 59 observations for each macroeconomic variable in the study which are basically all from the time of relatively stable economic growth. This may produce dubiously high correlation coefficients between the explanatory variables and thus cause multicollinearity in to the model (which of we will be discussing in the next section).

6.4.2 Multicollinearity – Correlation Matrixes

In order for a regression model to be robust it must be so that it does not suffer from severe multicollinearity between the explanatory variables. Dougherty (2007) state, however, that "the presence of multicollinearity does not mean that the model is misspecified. Accordingly, the regression coefficients remain unbiased and the standard errors remain valid."

In order to present the possible multicollinearity in our model, Table 10 shows the correlation matrix of the non-firm specific structural determinants.

Table 10: Correlation Coefficients Between Explanatory Variables
This table presents the correlation coefficients between our explanatory variables. The term 'Spot Rate' refers to the yield on a 10-year government treasury.

	VIX	SPX	Spot Rate	Slope	M&A
VIX	1.000	-0.408	-0.378	0.542	-0.579
SPX		1.000	0.633	-0.793	0.412
Spot Rate			1.000	-0.628	0.567
Slope				1.000	-0.537
M&A					1.000

As we can see from the table the correlation coefficients are in general quite high. The lowest correlation is between the spot rate and the VIX, whereas the largest one is between the S&P 500 index and the slope of the yield curve. However, according to Baltagi (2005), in regressions, where the correlation coefficients between the explanatory variables remains below 0.90 there should not exist a severe problem with multicollinearity. Thus we state that our model with structural determinants of credit spreads remains coherent despite the correlations between our variables.

6.4.3 Linear Interpolation

The use of linear interpolation when matching the maturities between corporate bonds and treasury bonds is a factor that may cause some inaccuracy in the sizes of the credit spreads, especially in the spreads of bonds with long maturities. This is because US treasury announces the yields for maturities of 1-year, 2-years, 3-years, 5-years, 7-years, 10-years, 20-years and 30-years. Thus the interpolation becomes less accurate when the maturity increases. As was also mentioned in Section 5.1.1 we used linear extrapolation for bonds with maturities over 30-years. Due to this the actual relation between the slope of the yield curve and the long-maturity bonds may be slightly differing than our model suggests.

Using linear interpolation, however, is not uncommon. For example Collin-Dufresne et al. (2001) used a similar type of linear interpolation in their study of credit spreads as we used in this study.

7. Conclusion

In this study we have focused on the pricing of corporate liabilities and the factors driving the changes in corporate credit spreads. We stated that the motivation for this study was to discover whether the already established variables are still able to explain changes in credit spreads and whether the three new variables introduced in this study have had the ability explain the changes in corporate credit spreads.

The results found are interesting. We found that from the already established structural variables of corporate credit spreads VIX and the Spot rate were clearly the strongest ones. These findings are in line with Collin-Dufresne et al. (2001), Huang Kong (2002) and Van Landschoot (2004). The explanatory strength of VIX and Spot Rate remained in all subgroups when the sample was categorized by maturity, industry, leverage ratio and credit rating. We also studied whether the S&P 500 is the best proxy for the business climate. We found that S&P 500 was clearly stronger driver for corporate credit spreads than the consumer confidence index or the unemployment rate. However, the explanatory strength of S&P 500 was often questionable and the sign of the coefficient was opposite to what the contingent claims theory implies. The most important finding of our study and the significant contribution of our study is the M&A activity's role in explaining corporate credit spreads. We found that the M&A activity, which works as a combined proxy for probability of a jump in firm asset value and for managers' risk aversion, is a statistically significant explanatory factor for corporate credit spreads. We found that an increase of 10 M&A deals (relatively large increase since during the observation period, an average of 64 deals were announced in each month), will result to a 3.6% increase in corporate credit spreads. The size of the coefficient seems reasonable, since although the effect of a jump in the value of firm's assets can have a vast effect on the value of its bonds, the probability of a jump in firm asset values can still be considered to be relatively small. We also found that the explanatory strength of M&A activity is much stronger for bonds with short maturities than for bonds with longer maturities. To conclude the findings of this study we claim that the results found in this study are important for both pricing corporate liabilities, and managing credit risk related to corporate liabilities. On the basis of this study, academics can have new ideas on how to

measure the structural determinants, and professionals such as portfolio managers may better be able to foresee the risk exposures of their positions.

We also took a look on the prevailing credit crisis in the US bond markets. We found that all our explanatory variables have encountered significant changes with the credit crisis. Every variable moved to the direction expected by our hypotheses, except the M&A activity, which slumped as a result of the credit crisis. Unfortunately, due to the ending date of our data, we were unable to run regressions for the credit crisis time period. However, the results shown by Figure 7 (page 73) are strong enough for stating that the variables behind the structural determinants of corporate credit spreads are fully applicable also for times of severe financial distress.

Finally, we are going to give some suggestions for further research. We feel that additional research on the ability of M&A activity to work as a proxy for jump in firm value should be studied. This would be useful for at least two reasons: first, because the prior proxies for jump in the value of firm's assets have been unable to provide consistent results, and second, because M&A activity as measured here, is as such unable to predict the size of the possible jump. Additional research could also be made by including the credit spread puzzle variables to the model explaining changes in credit spreads. However, due to their slowly changing characteristics (especially taxes) this kind of research should be done with relatively long time period. The author is also keen to find new research relating to the prevailing credit crisis in US, and on the question whether the variables behind the structural determinants of credit spreads have been able to explain the changes in credit spreads under times of exceptionally strong turbulence.

References

Altman E., and Kishore V., 1996, Almost everything you wanted to know about recoveries on defaulted bonds, *Financial Analysts Journal,* Nov/Dec 1996, 52, 6, pp. 57–64.

Amihud, Y., Mendelson, H., 1986. Asset pricing and the bid-ask spread. *Journal of Financial Economics* 17, pp. 223–249.

Asbaugh-Skaife H., Collins D., LaFond R., 2006, The effects of corporate governance on firms' credit ratings, *Journal of Accounting and Economics*, 42, (2006), pp. 203–243.

Baltagi B., 2005, Econometric Analysis of Panel Data, Third Edition, *Book*, John Wiley and Sons Ltd., 2005.

Batchelor R., Dua P., 1998, Improving macro-economic forecasts, The role of consumer confidence, *International Journal of Forecasting*, 14 (1998), pp. 71–81.

Bekaert G., Wu G., 2000, Asymmetric volatility and risk in equity markets, *Review of Financial Studies*, 13, 2000, pp. 1-42.

Black F., Cox J., 1976, Valuing Corporate Securities: Some Effects of Bond Indenture Provisions *The Journal of Finance*, Vol. 31, 1973, No. 2.

Black F., Scholes M., 1973, The Pricing of Option and Corporate Liabilities, *The Journal of Political Economy*, Vol. 81, No. 3. (May – Jun., 1973), pp. 637–654.

Chen L., Lesmond D., Wei J., 2005, Corporate Yield Spreads and Bond Liquidity, *Working Paper*, Michigan State University - Tulane University - University of Toronto.

Collin-Dufresne P., Goldstein R., Martin S., 2001, The Determinants of Credit Spread Changes, *The Journal of Finance*, Vol. 56, No. 6, (Dec., 2001), pp. 2177–2207.

Cox J., Ross S., Rubinstein M., 1979, Option Pricing: A Simplified Approach, *Journal of Financial Economics*, 7 (Sept. 1979), pp. 229–263.

Delianedis G., Geske R., 1999, The Components of Corporate Credit Spreads: Default, Recovery, Tax, Jumps, Liquidity, and Market Factors, *Working Paper*, The Anderson School at UCLA.

Dionne G., Gauthier G., Hammami K., Maurice M., Simonato J-G., 2005, Default Risk in Corporate Yield Spreads, *Working Paper 05–08*, HEC Montréal

Dougherty C., 2007, Introduction to Econometrics, *Book*, Oxford University Press.

Elton E., Gruber M., Agrawal D., Mann C., 2001 Explaining the Rate Spread on Corporate Bonds. *The Journal of Finance*, Vol. 56, No. 1. (Feb., 2001), pp. 247–277.

Edwards, A., Harris, L., Piwowar, M., 2005, Corporate Bond Market Transparency and Transaction Costs, *U.S. Securities and Exchange Commission*, Office of Economic Analysis.

Fabozzi F., 2005, The Handbook of Fixed Income Securities, Seventh Edition, *Book*, McGraw-Hill Companies.

Fons J., 1994, Using Default Rates to Model the Term Structure of Credit Risk, *Financial Analyst Journal*, Sep/Oct 1994, 50, 5, pp. 25 – 32.

He J., Hu W., Lang L., 2000, Credit Spread Curves and Credit Ratings, *Working Paper*, Chinese University of Hong Kong, 2000.

Huang J., Huang M., 2003, How Much of the Corporate-Treasury Yield Spread is Due to Credit Risk?, *Working Paper*, Penn State University – Stanford University

Huang J., Kong W., 2002, Explaining Credit Spread Changes: Some New Evidence from Option-Adjusted Spreads of Bond Indexes, *Working Paper*, Penn State University.

Hull J., White A., 1995, The impact of default risk on the prices of options and other derivatives securities, *Journal of Banking & Finance*, 19 (1995), pp.299–322.

Fisher I., 1930, The Theory of Interest, *Book*, The MacMillan Company, New York (1930).

Jarrow R., Turnbull S., 1995, Pricing Derivatives on Financial Securities Subject to Credit Risk, *The Journal of Finance*, Vol. 50, No. 1. (Mar., 1995), pp. 53–85.

Kagraoka Y., 2005, Corporate bond liquidity and matrix pricing, *Physica A*, 355 (2005) pp. 158–164.

Klock M., Mansi S., Maxwell W., 2005, Does Corporate Governance Matter to Bondholders?, *Journal of Financial and Quantitative Analysis*, Vol. 40, No. 4, Dec. 2005, pp. 693–719.

Kwan S., 1996, Firm-specific information and the correlation between individual stocks and bonds, *Journal of Financial Economics*, Vol. 40 (1996) pp. 63–80.

Leland H., Toft K., 1996, Optimal Capital Structure, Endogenous Bankruptcy, and the Term Structure of Credit Spreads, *The Journal of Finance*, Vol. 51, No.3, Jul. 1996, pp. 987 – 1019.

Litterman R., Scheinkman J., 1991, Common factors affecting bond returns, *Journal of Fixed Income,* Vol. 1 (1991), pp. 54–61.

Longstaff F., Schwartz E., 1995, A Simple Approach to Valuing Risky Fixed and Floating Rate Debt, *The Journal of Finance*, Vol. 50, No. 3, Jul., 1995, pp. 789–819.

Madan D., Unal H., 1999, A Two-Factor Hazard-Rate Model for Pricing Risky Debt and the Term Structure of Credit Spreads, *Working Paper*, Robert H. Smith School of Business, University of Maryland.

Metz A., 2006, Moody's Credit Rating Prediction Model, *Moody's Special Comment*, Moody's Investors Service, Global Credit Research, November 2006.

Merton R., 1973, Theory of Rational Option Pricing, *Bell Journal of Economics and Management Science,* 4 (spring 1973).

Merton R., 1974, On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, *The Journal of Finance*, (May, 1974), pp. 449–470.

Mueller C., 2000, A Simple Multi-Factor Model of Corporate Bond Prices, *Working Paper*, University of Wisconsin – Madison, 2000.

Ramaswamy K., Sundaresan S., 1986, The Valuation of Floating-Rate Instruments: Theory and Evidence, *Journal of Financial Economics*, 17 (1986), pp. 251–272.

Strock Bagnani E., Milonas N., Saunders A., Travlos N., 1994, Managers, Owners, and The Pricing of Risky Debt: An Empirical Analysis, *The Journal of Finance*, Vol. 49, No. 2, Jun. 1994, pp. 453–477.

Tsuji C., 2005, The credit-spread puzzle, *Journal of International Money and Finance*, 24 (2005), pp. 1073–1089.

Van Landschoot A., 2004, Determinants of Euro Term Structure of Credit Spreads, *Working Paper*, European Central Bank, No. 397, Oct 2004.

White H., 1980, A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity, *Econometrica*, Vol. 48, No. 4. (May, 1980), pp. 817-838.

Internet references:

http://en.wikipedia.org/wiki/VIX

http://seekingalpha.com/article/31069-investors-starting-to-demand-greater-rewards-for-risk-taken

http://www.cboe.com/micro/vix/introduction.aspx

http://www.conference-board.org/economics/ConsumerConfidence.cfm

http://www.pollingreport.com